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ABSTRACT

This kit contains materials for an eight hour course on home weatherization. This course is designed for: (1) work-crew supervisors; (2) secondary or post secondary vocational-technical students; and (3) adults wishing to improve their vocational-technical skills. Contained in this kit are: (1) a teacher's guide; (2) charts for an overhead projector; (3) a student manual; and (4) a home winterization job book. These materials promote the use of existing technology for home retrofitting. Lesson plans are provided in the teacher's guide. The job book is similar to an energy audit workbook. The student manual explains the how and why of winter comfort heating relative to this course. (MR)

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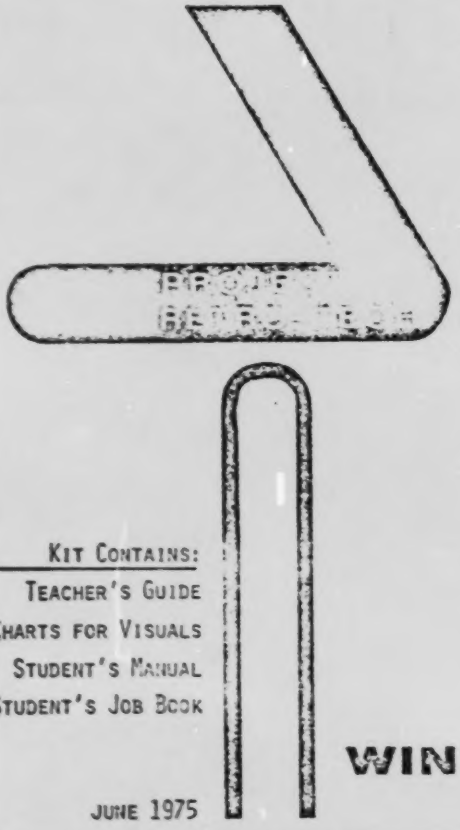

Federal Energy Administration
Washington
D.C.20461

TEACHER'S KIT for Course on HOME WINTERIZATION

KIT CONTAINS:
TEACHER'S GUIDE
CHARTS FOR VISUALS
STUDENT'S MANUAL
STUDENT'S JOB BOOK

JUNE 1975

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PREFACE

This booklet was prepared as a guide to teachers in developing lesson plans for a Home Winterization Course which promotes the utilization of known RETROfit TECHnology to improve thermal characteristics and conserve energy in residential housing.

Although the suggested lesson plans contained in this booklet have been designed for a special course for supervisors of work-crews actually engaged in home winterization, the concepts embodied in the individual lessons can also be incorporated into the curriculum of construction trades programs at vocational-technical schools at the secondary, post-secondary or adult education levels.

This material was developed for the Federal Energy Administration (FEA) by the following individuals at the University of Maine at Orono:

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Norman C. Smith, Professor Agricultural Engineering

Additional copies of the training materials used in the Home Winterization Course may be obtained, while the supply lasts, by writing to:

Federal Energy Administration
Region I
150 Causeway Street
Boston, Massachusetts 02114

FEA welcomes your ideas and comments about the Home Winterization Course. In addition, we would appreciate information from you regarding your use of the training materials, either for special groups or for vocational students pursuing a career in the construction trades. Your comments, along with any suggestions for improving the training materials should be mailed to the above address.

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Robert W. Mitchell
Regional Administrator
Region I

Project Retro-Tech

TEACHER'S GUIDE ON HOME WINTERIZATION

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FORWARD

PROJECT RETRO-TECH has evolved from efforts by the Federal Energy Adminisration (FEA) to fill a need expressed by various consumer groups. On the one hand, community services agencies which utilize Federal and State funds to winterize the homes of fixed and low-income elderly and families have pointed to a need for a source of technical know-how to improve the effectiveness of their winterizing measures, either in terms of higher fuel savings or reduced installation cost.

On the other hand, many consumer groups have pointed to the difficulty in locating qualified technicians who specialize in winterizing homes. Firms which sell either insulation or storm windows and doors are not always properly staffed with trained specialists who can make an overall assessment of thermal deficiencies and recommend optimum corrective action. Misapplication or lack of attention to any key element in the total winterization process can negate the fuel savings and cost savings resulting from the installation of insulation and storm windows.

The shortage of skilled and trained technicians who specialize in winterizing homes will be further aggravated during the next few years as homeowners turn to retrofit measures for relief from the higher costs of energy.

The expanding requirements for a large cadre of skilled technicians who have been trained in techniques for winterizing the homes of all segments of the population will place additional burdens on the vocational-technical schools at the secondary, post-secondary and adult education levels. The Home Winterization Course developed by FEA is designed to assist the vocational-technical schools to meet this challenge.

It should be pointed out, however, that the FEA Winterization Manual is only one of a series of training materials being developed by FEA, HUD, and private industry groups. These additional training materials, when they become available, will enable the vocational-technical schools, not only to expand the content of the initial Home Winterization Course, but also to add other courses to train the cadre of specialists which will be required to fill the many new business and employment opportunities being created as a result of the increased emphasis on home winterization by all segments of the population.

GENERAL LESSON PLAN

FOR

HOME WINTERIZATION COURSE

A. COURSE OBJECTIVES:

1. Given the FEA Winterization Manual and Job Book, which are based on known technology for retrofitting residential housing, the general objective of the Home Winterization Course for Work-Crew Supervisors is to train community services groups to utilize available technology when retrofitting residential housing, under government-aided winterizing programs, as an effective means for improving thermal characteristics of housing and reducing energy consumption.

2. Given the FEA Winterization Manual and Job Book (as well as other training materials as they are developed by FEA and others), the general objective is to enhance the vocational and avocational opportunities of youths and adults enrolled in both the accredited and non-accredited construction trades programs, by modifying the curriculum of these programs to include such courses, teaching modules and/or lesson units as may be appropriate to prepare students for the new business and employment opportunities that are being created as a result of increased emphasis on home winterization by all segments of the population.

B. INSTRUCTIONAL OBJECTIVES

1. ESTIMATION: Given the physical dimensions and construction features of a detached residential structure, a student will prepare for the homeowner a written analysis (Job Book), containing the following:

   a. Identification of gross thermal deficiencies of the structure which result in heat losses by infiltration and conduction;

   b. Comparison of current heating requirements with the potential savings;

c. Job Write-up, from which the material specifications and bill of materials will be prepared;

d. Bill of materials for the feasible remedies, including costs and pay-back period.

2. INSTALLATION: Given a job write-up (Job Book) for a detached residential structure, the student will describe and/or demonstrate to others the proper methods for installing the specified materials. In addition, the student will describe and/or demonstrate the method for conducting a post-evaluation at the end of a heating season to determine the actual energy saved by a retrofit program.

C. EQUIPMENT REQUIRED

The following equipment is required for the classroom lectures and/or demonstrations:

1 - Projection screen

1 - Overhead Projector

1 - Set of Transparancies (Prepare from charts contained in supplement to this Guide)

1 - Set 35 mm Slides - Optional (may be obtained on loan from the FEA Regional Office)

1 - Sample of common forms of insulation and other winterizing materials.

D. STUDENT MATERIALS

1. FEA Home Winterization Manual
2. FEA Home Winterization Job Book

E. LESSONS

Lesson plans are included in this booklet on the following topics:

No.	Topic	Suggested Class Time (hr:min)
1.	Overview of Course.....	0:30
2.	Introduction to Heat Loss.....	0:30
3.	Heat Loss By Conduction.....	1:00
4.	Heat Loss By Infiltration.....	0:30
	Home Winterization in 4 Steps	
5A.	Step 1 - Inspection.....	0:30
5B.	Step 2 - Calculation.....	0:30
5C.	Step 3 - Evaluation.....	1:00
5D.	Step 4 - Installation.....	3:00
6.	Job Book Example by Students.....	0:30
	Total Suggested Class Time	8:00

F. INSTRUCTIONAL STRATEGIES

1. Course for Work-Crew Supervisors

In cooperation with the State Energy Office and the State Office of Economic Opportunity, technical-vocational schools are encouraged to offer this 8 to 12 hour training course to work-crew supervisors, foremen or estimators who are engaged in government-sponsored programs for winterizing the homes of fixed and low-income elderly and families.

2. Post-Secondary and/or Secondary Vocational-Technical Program

For students who are pursuing a career in residential construction and/or retrofitting field, the vocational-technical schools are encouraged to modify their vocational programs by incorporating one or more of the lesson units into such related courses as carpentry, residential construction/rehabilitation, and HVAC.

3. Adult Education Program

For adults who wish to enhance their vocational or avocational opportunities, the vocational-technical schools are encouraged to conduct non-credit courses in home winterization based upon the existing as well as the forthcoming training materials being developed by FEA and others.

G. FORMAT OF LESSON PLANS

The lesson plans which begin on the following page contain "Points of Emphasis" to be covered by the teacher during the classroom lecture. Adjacent to each emphasis point is a page reference in the student's Manual, and the Chart No. of the visual aid to be used to reinforce the emphasis point.

The visual aids, either transparencies for overhead projection or 35mm slides, should be prepared locally from the set of 8" x 10-1/2" charts contained in separate package which accompanies this Teacher's Guide. Each chart is numbered to coincide with the appropriate Point of Emphasis.

If equipment is not available to you for preparing transparencies from the accompaning charts, several sets of transparencies have been distributed to each State Energy Office in New England for use in the vocational-technical schools.

For the convenience of the Teacher when reviewing a Lesson Plan, each chart appears in miniature at the bottom of the appropriate page of the Teacher's Guide.

LESSON PLAN NO. 1 OVERVIEW OF COURSE

POINTS OF EMPHASIS		Manual Page	Chart No.
1.	Objective(s) of Course: a. Learn to use simplified techniques for utilizing known technology when retrofitting residential structures to improve thermal characteristics and reduce energy consumption. b. _____ _____ _____		C-1

(Lesson continued on next page)

Chart C - 1

PROJECT *RETRO-TECH*

HOME

WINTERIZATION

COURSE

Chart C - 2

INSTRUCTIONAL OBJECTIVES

ESTIMATION

STUDENT WILL PREPARE WRITTEN ANALYSIS CONTAINING:

(1) IDENTIFICATION OF DEFICIENCIES
(2) COMPARISON OF REQUIREMENTS/SAVINGS
(3) JOB SPECIFICATIONS
(4) BILL OF MATERIALS

INSTALLATION

STUDENT WILL:

(1) SUPERVISE APPLICATION
(2) CONDUCT POST-EVALUATION

(Continued from previous page)

	POINTS OF EMPHASIS	Manual Page	Chart No.
2.	Instructional Objectives Estimation: Given the physical dimensions and construction features of a detached residential structure, a student will prepare for the homeowner a written analysis (Job Book), containing the following: (a) Identification of gross thermal deficiencies of the structure which result in heat losses by infiltration and conduction; (b) Comparison of current heating requirements with the potential savings; (c) Job Write-up, from which the material specifications and bill of materials will be prepared; (d) Bill of materials for the feasible remedies, including costs and pay-back period. Installation: Given a job write-up (Job Book) for a detached residential structure, the student will describe and/or demonstrate to others the proper methods for installing the specified materials. In addition, the student will describe and/or demonstrate the method for conducting a post-evaluation at the end of a heating season to determine the actual energy saved by a retrofit program. (Lesson continued on next page)		

LESSON PLAN NO. 1 OVERVIEW OF COURSE

(Continued from previous page)

	POINTS OF EMPHASIS	Manual Page	Chart No.
3.	Course Content: (a) Introduction to Heat Loss (b) Building Heat Loss by Conduction (c) Building Heat Loss by Infiltration (d) 4 Steps to Home Winterization Optional: (e) Laboratory Exercises _____ (f) Field Exercises _____ (End of Lesson No. 1)		C-3

Chart C - 3

HOME WINTERIZATION COURSE

LESSONS

A. INTRODUCTION TO HEAT LOSS

B. BUILDING HEAT LOSS BY CONDUCTION

C. BUILDING HEAT LOSS BY INFILTRATION

D. 4 STEPS TO HOME WINTERIZATION

LESSON PLAN NO. 2 INTRODUCTION TO HEAT LOSS

	POINTS OF EMPHASIS	Manual Page	Chart No.
1.	Most homes can use much less fuel without sacrificing comfort. Fuel can be saved by improving building.	1	C-4
2.	It is not the "Cold" that comes in; it is the "Heat" we buy that escapes to the outside.	1	C-5

(Lesson continued on next page)

Chart C - 4

MOST HOMES
CAN USE
MUCH LESS FUEL
WITHOUT
SACRIFICING
COMFORT

Chart C - 5

IT IS NOT THE
COLD
THAT COMES IN····
IT IS THE
HEAT WE BUY
THAT ESCAPES
TO THE OUTSIDE

LESSON PLAN NO. 2 INTRODUCTION TO HEAT LOSS

(Continued from previous page)

	POINTS OF EMPHASIS	Manual Page	Chart No.
3.	Heat which escapes must be replaced.	2	C-6
4.	When less heat escapes, less fuel is required.	2	C-7

(Lesson continued on next page)

Chart C - 6

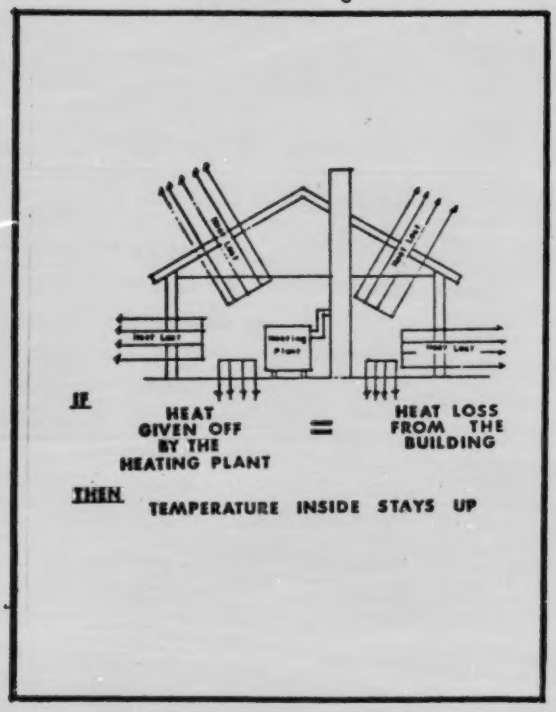
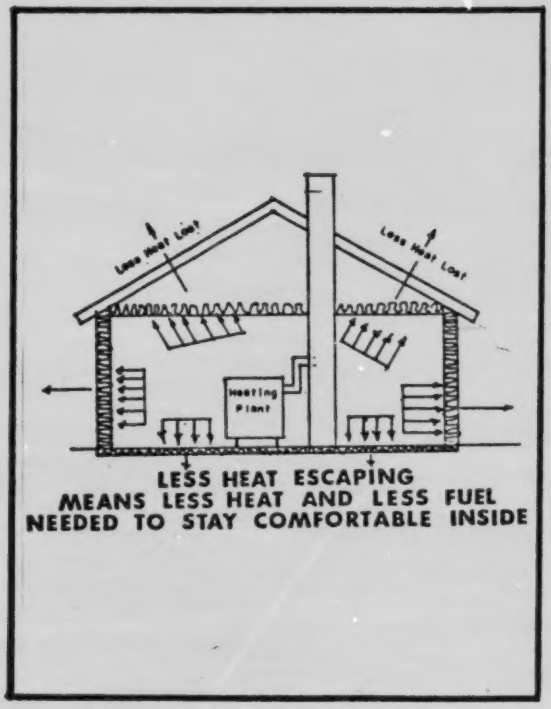


Chart C - 7



LESSON PLAN NO. 2 INTRODUCTION TO HEAT LOSS

(Continued from previous page)

	POINTS OF EMPHASIS	Manual Page	Chart No.
5.	"BTU" as a unit of measure, is very small.	4	C-8
6.	Heating Unit concept will simplify calculations. One heating unit represents about 1000 BTUs.	3	C-9

(Lesson continued on next page)

Chart C - 8

1 British Thermal Unit (B.T.U.)

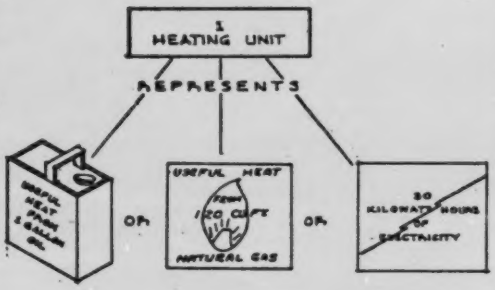
IS

THE HEAT NEEDED TO RAISE ONE POUND OF WATER ONE DEGREE FAHRENHEIT

---- APPROXIMATELY THE HEAT GIVEN OFF BY BURNING

ONE KITCHEN MATCH

Chart C - 9



LESSON PLAN NO. 2 INTRODUCTION TO HEAT LOSS

(Continued from previous page)

	POINTS OF EMPHASIS	Manual Page	Chart No.
7.	Heating requirements are calculated on seasonal basis to determine total fuel use.	3	C-10
8.	District Heating Factor concept allows for climatic differences between areas.	3	C-11 C-12

(Lesson continued on next page)

Chart C - 10

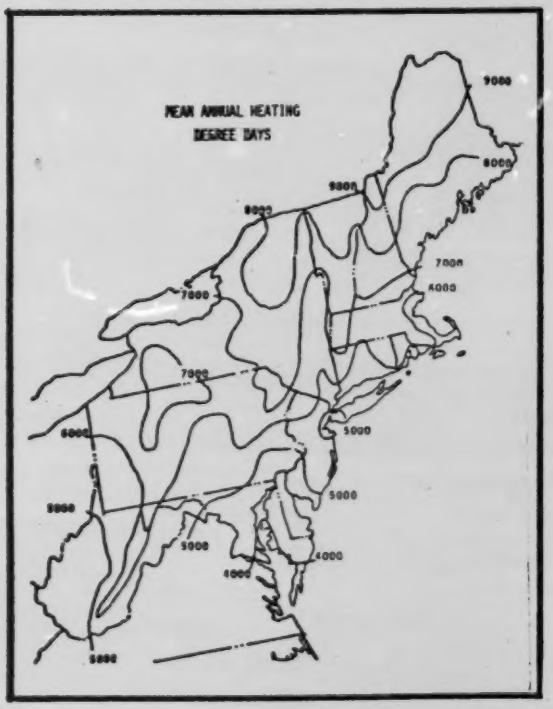


Chart C - 11

IF
THE AREA HAS
4000 HEATING
DEGREE DAYS __

THE
DISTRICT HEATING
FACTOR
IS
1

LESSON PLAN NO. 2 INTRODUCTION TO HEAT LOSS

(Continued from previous page)

	POINTS OF EMPHASIS	Manual Page	Chart No.
9.	HOME WINTERIZATION IS A 4-STEP PROCESS:	3	C-13
	(a) STEP 1: INSPECTION OF THE BUILDING Inspect the building to determine its construction characteristics.	3	C-14
	(b) STEP 2: CALCULATION OF HEAT LOSSES Calculate the heat losses from the house.	3	"

(Lesson continued on next page)

Chart C -12

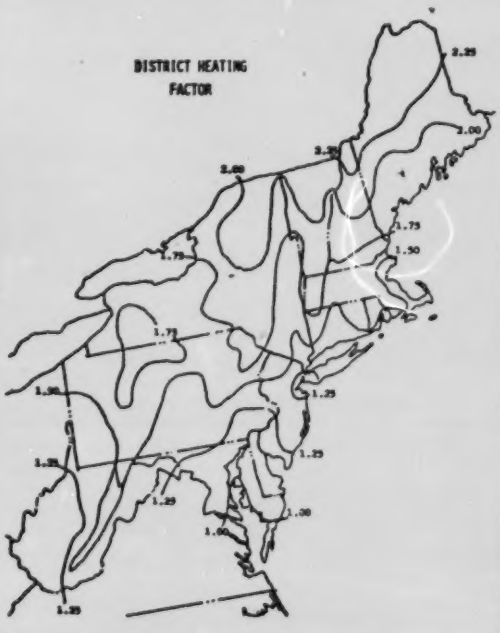


Chart C - 13

HOME

WINTERIZATION

IS A

4 STEP

PROCESS

LESSON PLAN NO. 2 INTRODUCTION TO HEAT LOSS

continued from previous page

	POINTS OF EMPHASIS	Manual Page	Chart No.
	(c) STEP 3: EVALUATION OF THE DATA Evaluate the building characteristics and heat losses to determine what measures should be taken.	3	(C-14
	(d) STEP 4: INSTALLATION OF MATERIALS Install the winterizing materials.	3	"
10.	JOB BOOK has been designed for recording this information on each separate building to be winterized.		C-15

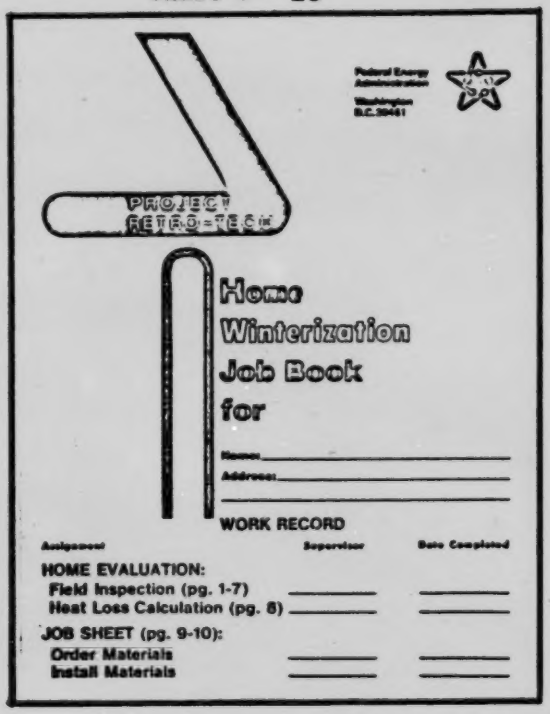
(End of Lesson No. 2)

Chart C - 14

4-STEP PROCESS

1. INSPECTION OF THE BUILDING
2. CALCULATION OF HEAT LOSSES
3. EVALUATION OF THE DATA
4. INSTALLATION OF THE MATERIALS

Chart C - 15



LESSON PLAN NO. 3 BUILDING HEAT LOSS BY CONDUCTION

	POINTS OF EMPHASIS	Manual Page	Chart No.
1.	Heat loss by Conduction means heat removed by flow through the exterior materials.	4	C-16
2.	Rate of Heat Loss depends upon: - Area of surface - Length of time - Type of material - Temperature difference across the surface.	4	C-17
3.	Materials which have low rate of heat flow are thermal insulators.	4	C-17

(Lesson continued on next page)

Chart C - 16

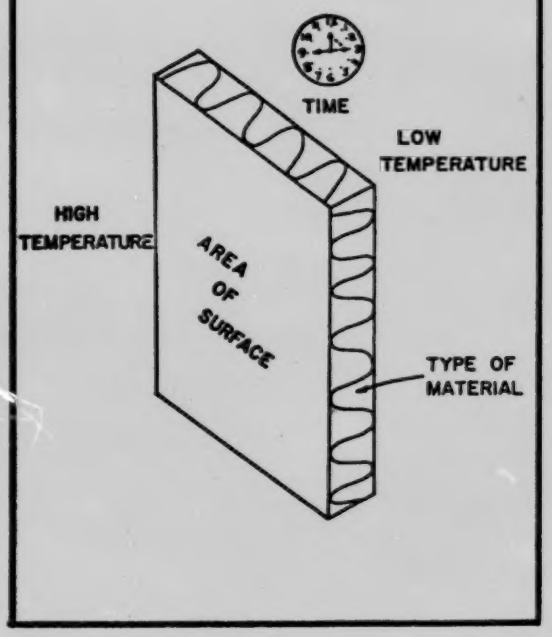
CONDUCTION

HEAT LOST

THROUGH THE

EXTERIOR SURFACES

Chart C - 17



(continued from previous page)

	POINTS OF EMPHASIS	Manual Page	Chart No.
4.	Types of insulation material commonly used in building construction are:	4	-
	(a) Loose Fill - Glass or rockwool, wood fiber, plastics - Low cost - Use on horizontal surfaces - Will settle	4	(Show Sample of each)
	(b) Blanket or Batt - Glass or rockwool, wood fiber - Low cost - Most common - Common thickness 3-1/2" to 6" - Common widths 16" & 24" - Blankets comes in rolls - Batts come in shorter lengths - Both come with, or without, vapor barrier.	4	(Show Sample of each)
	(c) Rigid Insulation - Fiber boards, foamed plasters - Higher cost - Generally not used for home winterization.	4	(Show Sample of each)
5.	Insulating value of material is measured by its Resistance, or "R" value. The higher the "R" value, the better the insulation.	6	

(Lesson continued on next page)

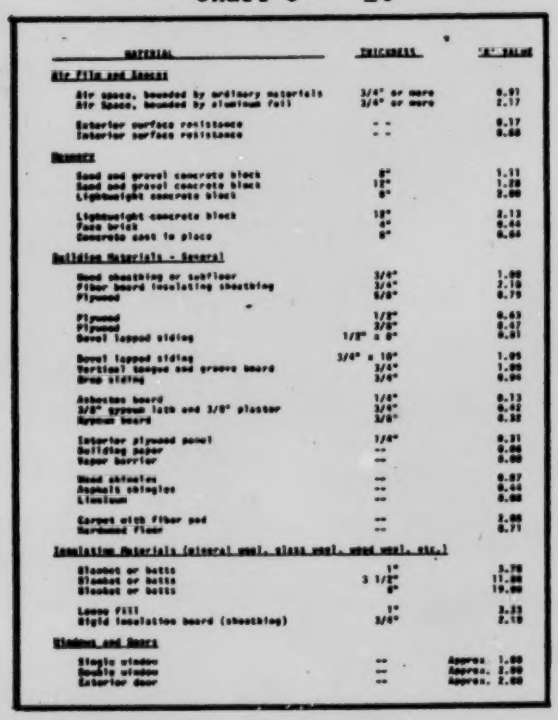
LESSON PLAN NO. 3 BUILDING HEAT LOSS BY CONDUCTION

(continued from previous page)

	POINTS OF EMPHASIS	Manual Page	Chart No.
6.	From the table of "R" values in the Manual, compare the values of some common materials found in house construction:	6	C-18
	(a) Air Film and Spaces	6	C-19
	(b) Masonry	6	C-19

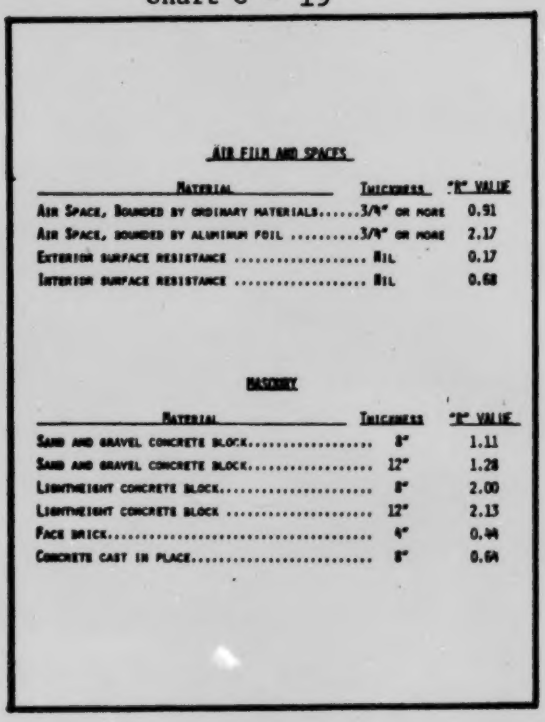
(Lesson continued on next page)

Chart C - 18



Material	Thickness	"R" Value
Air Film and Spaces		
Air space, bounded by ordinary materials	3/4" or more	0.91
Air Space, bounded by aluminum foil	3/4" or more	2.17
Exterior surface resistance	: :	0.17
Interior surface resistance	: :	0.68
Masonry		
Sand and gravel concrete block	8"	1.11
Sand and gravel concrete block	12"	1.28
Lightweight concrete block	8"	2.00
Lightweight concrete block	12"	2.13
Face brick	4"	0.44
Concrete cast in place	8"	0.64
Building Materials - General		
Wood sheathing or subfloor	3/4"	1.00
Fiber board insulating sheathing	1/2"	2.10
Plywood	5/8"	0.79
Plywood	1/2"	0.63
Plywood	3/8"	0.47
Bevel lapped siding	1/2" x 8"	0.81
Bevel lapped siding	3/4" x 10"	1.05
Vertical tongue and groove board	3/4"	1.00
Drop siding	3/4"	0.94
Asbestos board	1/4"	0.13
3/8" gypsum lath and 3/8" plaster	3/4"	0.32
Gypsum board	3/8"	0.32
Interior plywood panel	1/4"	0.31
Building paper	--	0.06
Vapor barrier	--	0.00
Wood shingles	--	0.87
Asphalt shingles	--	0.44
Linoleum	--	0.08
Carpet with fiber pad	--	2.08
Hardwood floor	--	0.71
Insulating Materials (mineral wool, glass wool, wood wool, etc.)		
Blanket or batts	1"	3.70
Blanket or batts	3 1/2"	11.00
Blanket or batts	6"	19.00
Loose fill	1"	3.33
Rigid insulation board (sheathing)	1/2"	2.10
Windows and Doors		
Single window	--	Approx. 1.00
Double window	--	Approx. 2.00
Exterior door	--	Approx. 2.00

Chart C - 19



AIR FILM AND SPACES

Material	Thickness	"R" Value
Air Space, Bounded by ordinary materials	3/4" or more	0.91
Air Space, bounded by aluminum foil	3/4" or more	2.17
Exterior surface resistance	Nil	0.17
Interior surface resistance	Nil	0.68

MASONRY

Material	Thickness	"R" Value
Sand and gravel concrete block	8"	1.11
Sand and gravel concrete block	12"	1.28
Lightweight concrete block	8"	2.00
Lightweight concrete block	12"	2.13
Face brick	4"	0.44
Concrete cast in place	8"	0.64

LESSON PLAN NO. 3 BUILDING HEAT LOSS BY CONDUCTION

(continued from previous page)

	POINTS OF EMPHASIS	Manual Page	Chart No.
	(c) Building Materials - General	6	C-20
	(d) Insulation Materials	6	C-21
	(e) Windows and Doors	6	C-21

(Lesson continued on next page)

Chart C - 20

BUILDING MATERIALS

Material	Thickness	"R" Value
Wood sheathing on subfloor	3/4"	1.00
Fiber board insulating sheathing	3/4"	2.10
Plywood	5/8"	0.79
Plywood	1/2"	0.63
Plywood	3/8"	0.47
Bevel lapped siding	1/2" x 8"	0.81
Bevel lapped siding	3/4" x 10"	1.05
Vertical tongue and groove	3/4"	1.00
Drop siding	3/4"	0.94
Asbestos board	1/3"	0.13
3/8" gypsum lath and 3/3" plaster	3/4"	0.42
Gypsum board	3/8"	0.32
Interior plywood paneling	1/4"	0.31
Building paper	—	0.06
Vapor barrier	—	0.00
Wood shingles	—	0.87
Asphalt shingles	—	0.44
Linoleum	—	0.08
Carpet with fiber pad	—	2.08
Hardwood floor	—	0.71

Chart C - 21

INSULATION MATERIALS

Materials	Thickness	"R" Value
Blanket or batts	1"	3.70
Blanket or batts	3-1/2"	11.00
Blanket or batts	6"	19.00
Loose fill	1"	3.35
Rigid insulation board (sheathing)	3/4"	2.10

WINDOWS AND DOORS

To simplify calculations, use the following approximate 'R' values.

Material	"R" Value
Single window	1.00
Double window	2.00
Exterior Door	2.00

LESSON PLAN NO. 3 BUILDING HEAT LOSS BY CONDUCTION

(continued from previous page)

	POINTS OF EMPHASIS	Manual Page	Chart No.
7.	"R" values of materials can be added together to obtain an overall resistence, or "R" value of a building section.		
	(a) Typical overall "R" for wall section.	4	C-22
	(b) Typical overall "R" for ceiling.	5	C-23

(Lesson continued on next page)

Chart C - 22

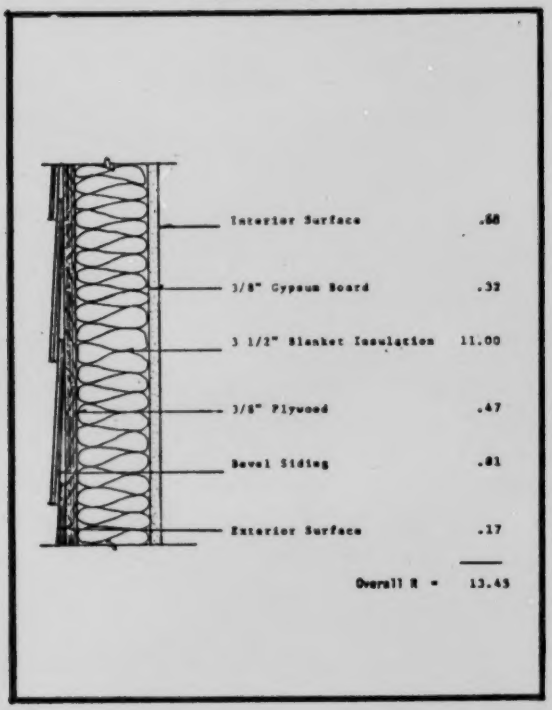
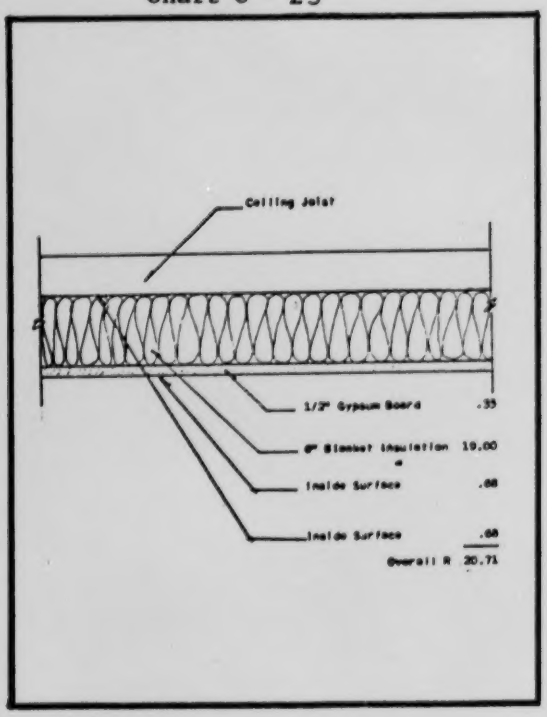


Chart C - 23



(Continued from previous page)

	POINTS OF EMPHASIS	Manual Page	Chart No.
	(c) Typical overall "R" for Roof.	5	C-24
	(d) Typical overall "R" for Floor.	5	C-25
8.	Vapor Barrier: Moisture in air exerts pressure. Moisture flows from high pressure side to low pressure side. As moisture flows from inside to outside, the temperature drops. When the dew point is reached, the moisture condenses, causing wetting of insulation and framing.	5	C-26

(Lesson continued on next page)

Chart C - 24

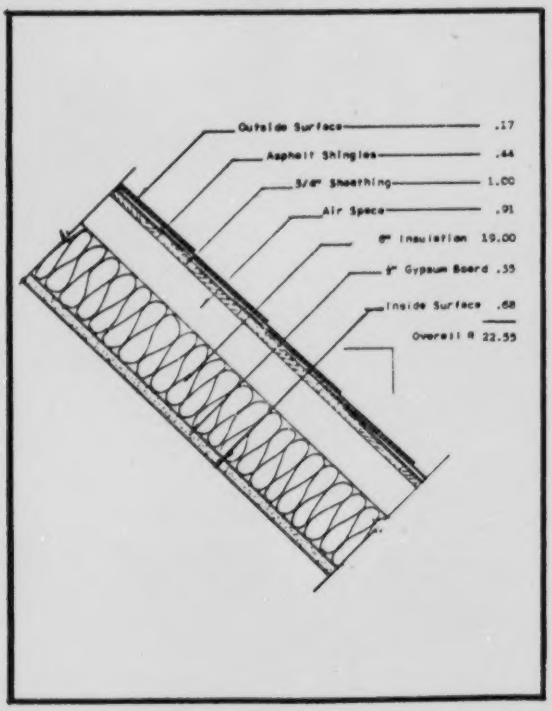
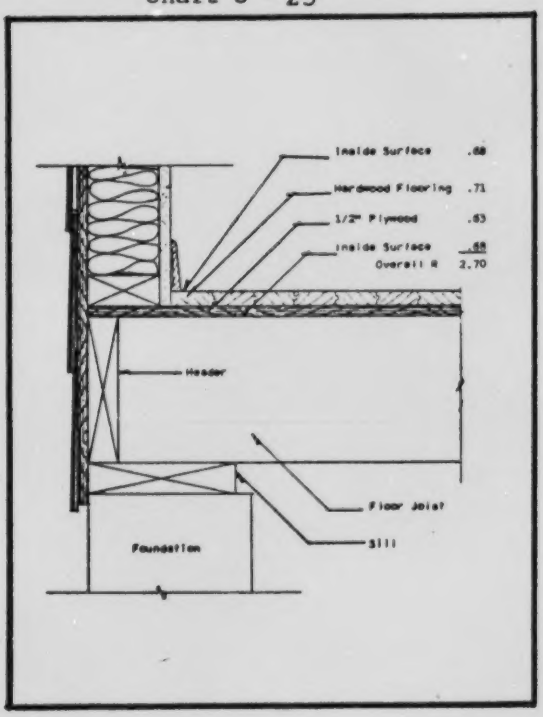


Chart C - 25



(Continued from previous page)

POINTS OF EMPHASIS	Manual Page	Chart No.
Since vapor barrier will reduce the flow of moisture before it reached the insulation, place the vapor barrier on the inside (warm side). (a) Poly film and aluminum foil are excellent; kraft paper is average. (b) Seal with pressure joint. Remove moisture that escapes through vapor barrier by venting to the outside. (End of Lesson No. 3)		

(Lesson No.4 starts on next page)

Chart C -26

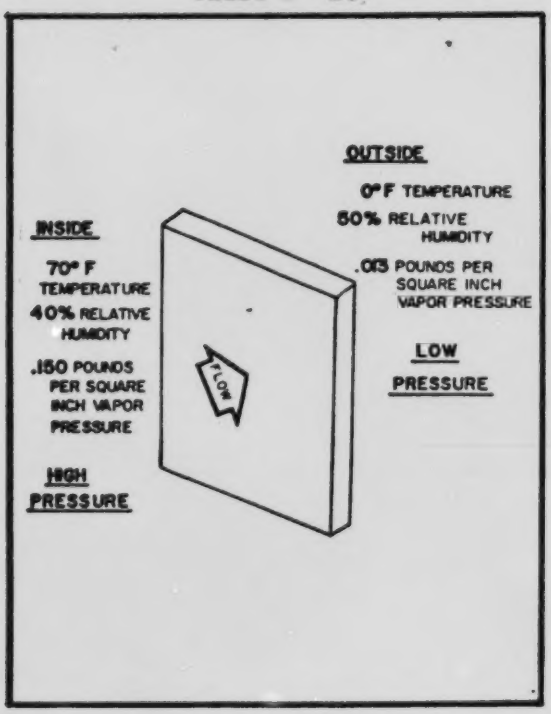


Chart C -27

LESSON PLAN NO. 4 BUILDING HEAT LOSS BY INFILTRATION

	POINTS OF EMPHASIS	Manual Page	Chart No.
1.	Heat is lost by cold air coming in and warm air going out. This leakage or infiltration is caused by two factors:	7	C-27
	(a) Infiltration by Wind occurs when wind flows in on one side and warm air flows out on the leeward side.	7	C-28
	(b) Infiltration by "Chimney Effect" occurs when inside air is warmer than outside air. The building acts like a chimney: heated air which tends to rise leaks out of cracks, and is replaced by cold air which is sucked in at lower levels.	7	C-29

(Lesson continued on next page)

Chart C - 28

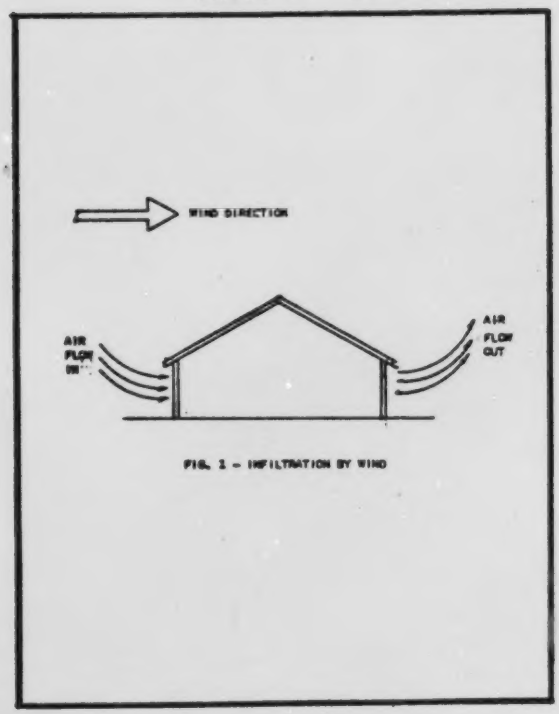


FIG. 1 - INFILTRATION BY WIND

Chart C - 29

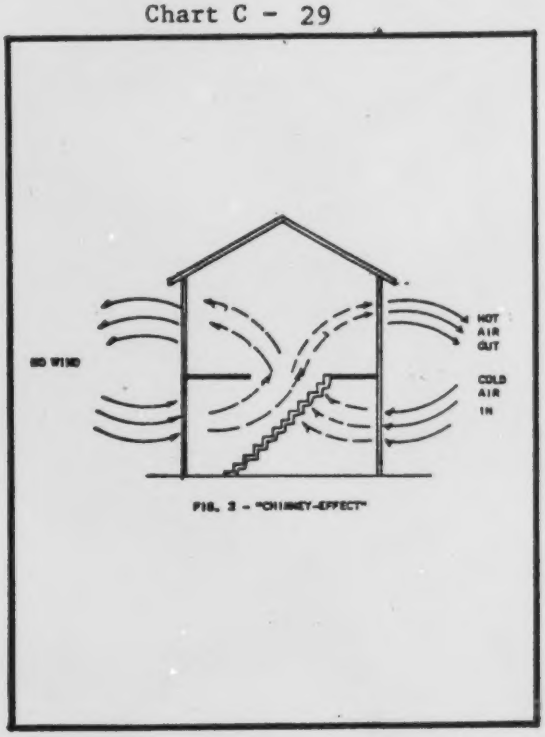


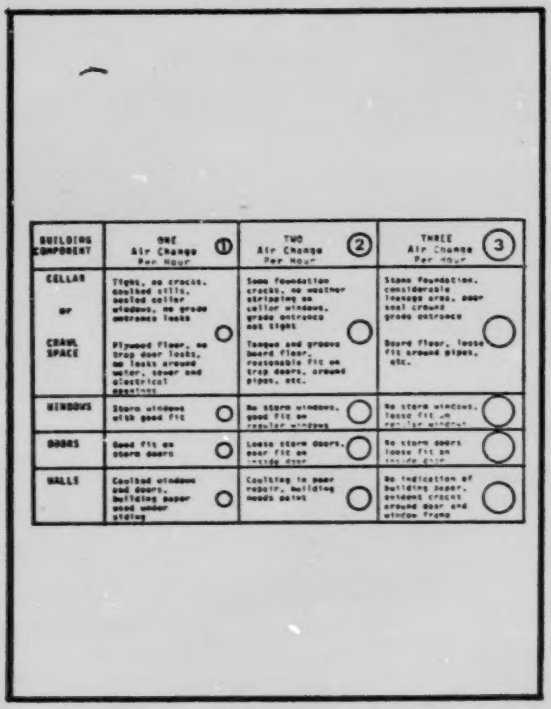
FIG. 2 - "CHIMNEY-EFFECT"

(Continued from previous page)

	POINTS OF EMPHASIS	Manual Page	Chart No.
2.	Each cubic ft. of air that must be heated requires 0.02 BTU for every one degree F increase.	7	-
3.	Infiltration Check List describes the typical conditions which result in infiltration rates of one, two and three air changes per hour.	10	C-30
	End of Lesson No. 4		

(Lesson No. 5A starts on next page)

Chart C - 30



BUILDING COMPONENT	ONE Air Change Per Hour ①	TWO Air Change Per Hour ②	THREE Air Change Per Hour ③
CELLAR or CRAWL SPACE	Tight, no cracks. Caulked sills, sealed cellar windows, no grade entrance leaks Plywood floor, no trap door leaks, no leaks around water, sewer and electrical openings	Some foundation cracks, no weather stripping on cellar windows, grade entrance not tight Tongue and groove board floor, reasonable fit on trap doors, around pipes, etc.	Stone foundation, considerable leakage area, poor seal around grade entrance Board floor, loose fit around pipes, etc.
WINDOWS	Storm windows with good fit	No storm windows, good fit on regular windows	No storm windows, loose fit on regular windows
DOORS	Good fit on storm doors	Loose storm doors, poor fit on inside door	No storm doors loose fit on inside door
WALLS	Caulked windows and doors, Building paper used under siding	Caulking in poor repair, building needs paint	No indication of building paper, apparent cracks around door and window frame

LESSON PLAN NO. 5A HOME WINTERIZATION IN 4 STEPS

STEP 1 - INSPECTION

	POINTS OF EMPHASIS	Manual Page	Chart No.
1.	(Refresher from Introduction Section) HOME WINTERIZATION IS A 4 STEP PROCESS: (a) STEP 1 - INSPECT the building to determine its construction characteristics (b) STEP 2 - CALCULATE the heat losses from the building. (c) STEP 3 - EVALUATE the building characteristics and heat losses to determine what measures should be taken. (d) STEP 4 - INSTALL the winterizing materials.	3	
2.	JOB BOOK is designed to enable a Work-Crew Supervisor (or Job Estimator) to follow this 4-step process in a systematic manner. Perhaps, the best way to become familiar with the JOB BOOK is to simulate the process by working out an example of a building to be winterized. The charts that you will see have been marked up to show the information that an Estimator will obtain when he inspects the building to determine the construction characteristics.		

(Lesson continued on next page)

(continued from previous page)

	POINTS OF EMPHASIS	Manual Page	Chart No.
3.	STEP 1 - INSPECT the building to determine the contruction characteristics.	9	C-31
	(a) Visual inspection of building should consist of the 10 steps listed on chart.	9	C-32
	(TEACHER OPTION FOR EMPHASIS POINT NO. 3(a)		
	Show 35mm color slides. See page 28.		
	Slides are available on loan basis.		

(Lesson continued on next page)

Chart C -31

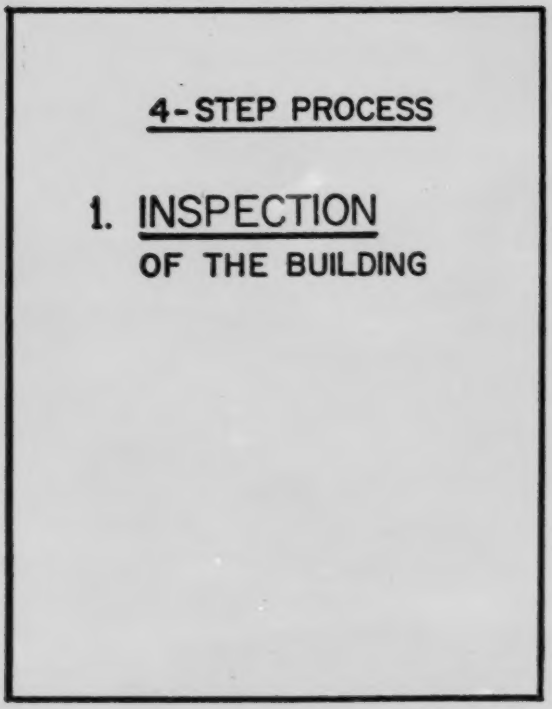
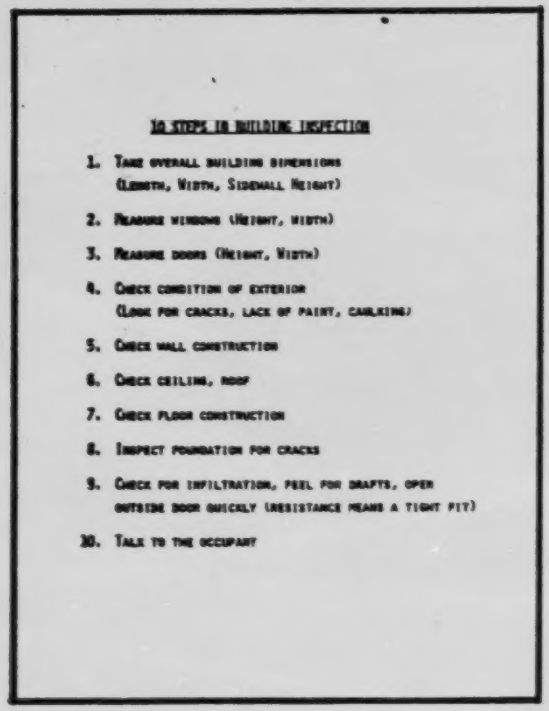


Chart C - 32


10 STEPS IN BUILDING INSPECTION
1. TAKE OVERALL BUILDING DIMENSIONS (LENGTH, WIDTH, SIDEWALL HEIGHT)
2. MEASURE WINDOWS (HEIGHT, WIDTH)
3. MEASURE DOORS (HEIGHT, WIDTH)
4. CHECK CONDITION OF EXTERIOR (LOOK FOR CRACKS, LACK OF PAINT, CAULKING)
5. CHECK WALL CONSTRUCTION
6. CHECK CEILING, ROOF
7. CHECK FLOOR CONSTRUCTION
8. INSPECT FOUNDATION FOR CRACKS
9. CHECK FOR INFILTRATION, FEEL FOR DRAFTS, OPEN OUTSIDE DOOR QUICKLY (RESISTANCE MEANS A TIGHT FIT)
10. TALK TO THE OCCUPANT

(Continued from previous page)

POINTS OF EMPHASIS	Manual Page	Chart No.
(b) Fill in the JOB BOOK: During the inspection, fill in the sections of JOB BOOK marked "Fill In At The Site". (NOTE: The student will be able to follow the Teacher's instructions by referring to the example which follows page 12 on the Home Winterization Manual).	9	
(1) Cover: Name and Address	9	C-33
(2) Page 1: Description of Building	9	C-34
(3) Page 1A: Dwelling & Heating Information	9	C-35
(4) Page 2: Infiltration Table	9	C-36
(5) Page 3: Table of Floor Materials	9	C-37
(6) Page 4: Table of Ceiling/ Roof Materials	9	C-38
(7) Page 7: Table of Wall Materials	9	C-39
(8) Page 9: Directions to House Location	10	C-40
End of Lesson 5A		

(Lesson No. 5B starts on Page 29)

Chart C - 33

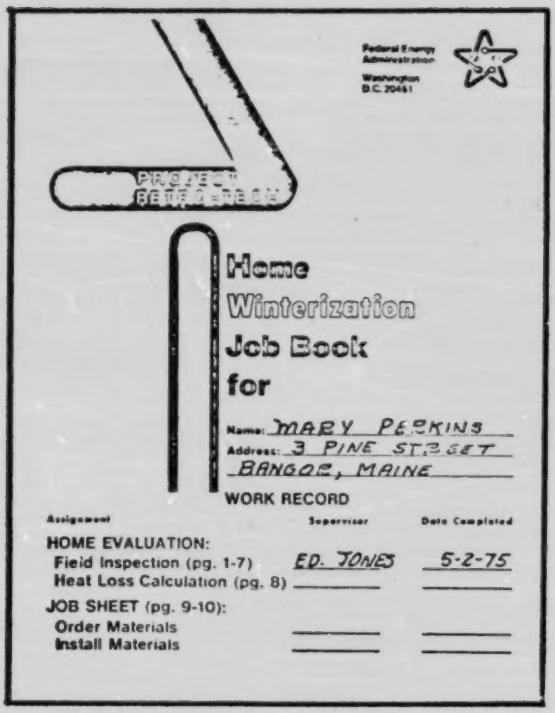


Chart C - 34

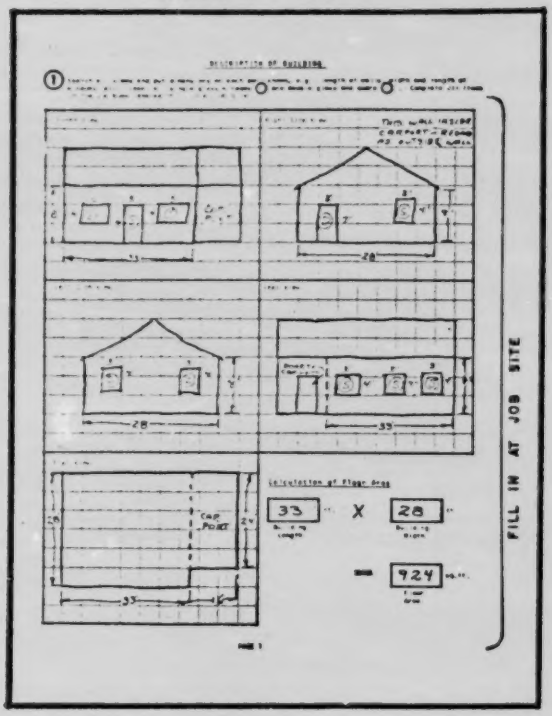


Chart C - 35

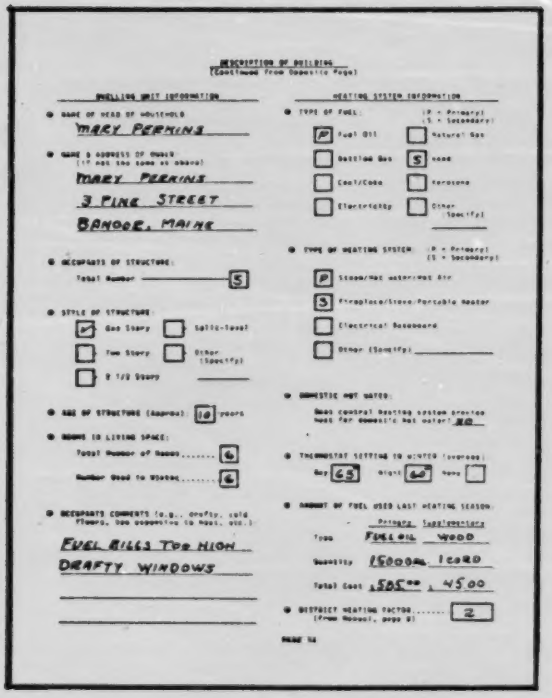


Chart C - 36

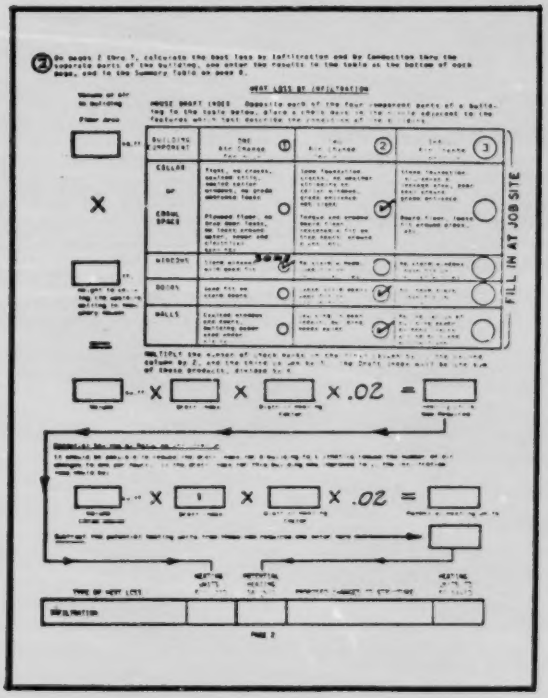


Chart C - 37

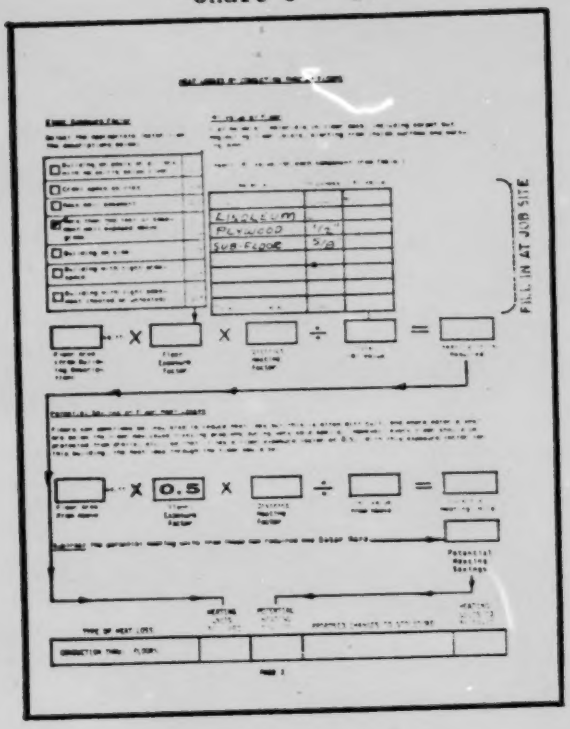


Chart C - 38

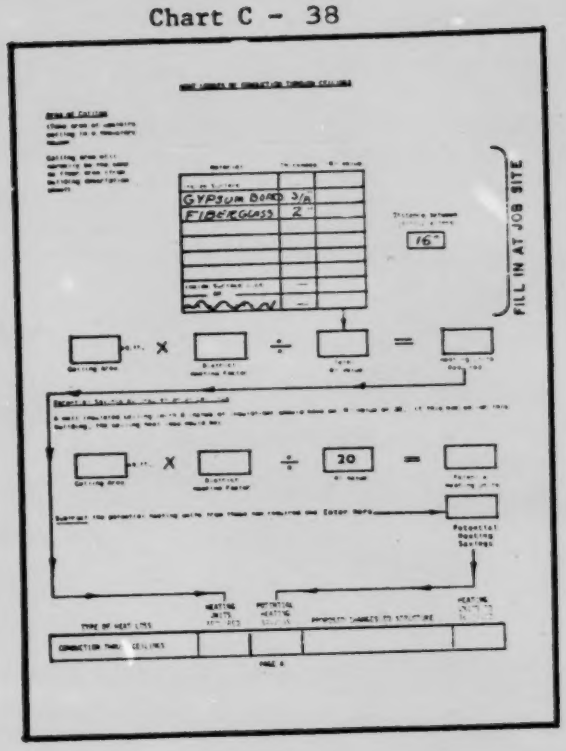


Chart C - 39

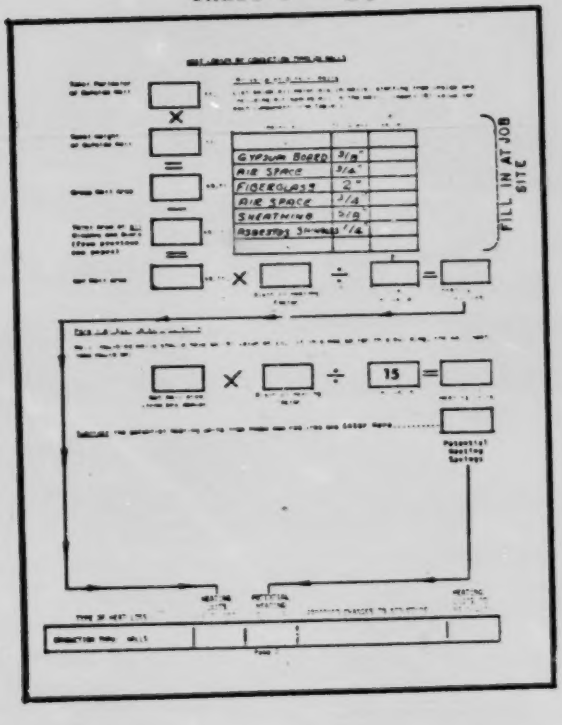
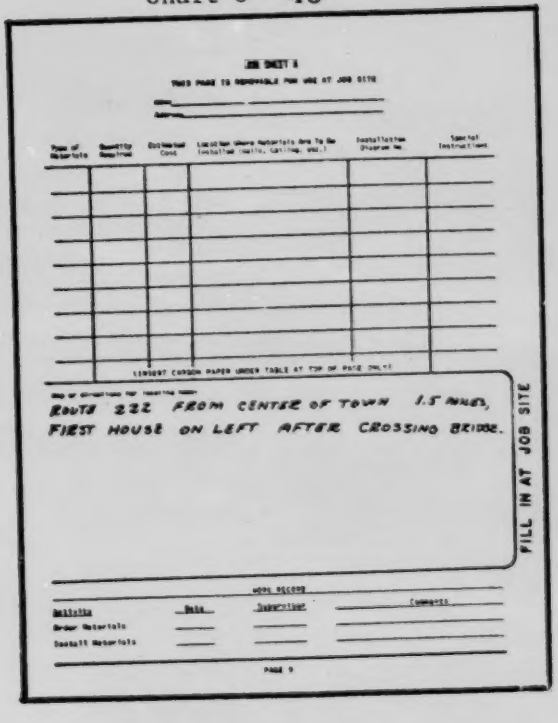


Chart C - 40



LESSON PLAN NO. 5A STEP 1 - INSPECTION

(Optional - See page 24)

	POINTS OF EMPHASIS	Manual Page	Chart No.
	TEACHER OPTION FOR EMPHASIS POINT NO.3(a)		
	(NOTE: In place of Chart C-32, the following 35mm color slides may be used to give the students a visual impression of the construction features of the building in the example to be worked out by the class. If these slides are not available from the State Department of Education, they may be obtained on a loan basis from the Regional Office of the Federal Energy Administration).		
3.	(a) Visual inspection of building:		
	(1) Front view		S-1
	(2) Right side view (showing carport)		S-2
	(3) Rear view		S-3
	(4) Left Side View		S-4
	(5) Take overall dimensions		S-5
	(6) Measure windows		S-6
	(7) Measure Doors		S-7
	(8) Speak to occupant		S-8
	(9) Check condition of exterior		S-9
	(10) Check wall construction		S-10
	(11) Check ceilings, roof, floors		S-11
	(12) Inspect foundation		S-12
	(13) Look for cracks and crevices		S-13
	(14) Check for infiltration		S-14
	(TURN OFF SLIDE PROJECTOR)	(END OF SLIDES)	

(Emphasis Point No.3(b) is back on page 25)

LESSON PLAN NO. 5B HOME WINTERIZATION IN 4 STEPS

STEP 2 - CALCULATION

	POINTS OF EMPHASIS	Manual Page	Chart No.
1.	STEP 2 - CALCULATE the heat losses expected during a complete heating season. (These simple calculations do not have to be done at the job site). (NOTE: The JOB BOOK pages shown on charts C-41 thru C-51 are to be completed during class time by teacher and students. Copies of the completed charts are included in this Guide and in the Manual). (Lesson continued on next page).	11	C-41

Chart C -41

4-STEP PROCESS

1. INSPECTION OF THE BUILDING
2. CALCULATION OF HEAT LOSSES

(Continued from previous page)

POINTS OF EMPHASIS	Manual Page	Chart No.
(a) JOB BOOK Page 2: Heat Losses by Infiltration (1) Enter Floor Area and Ceiling Height from page 1. Calculate volume of building. (2) Estimate the Draft Index based on the check marks in table. (1 air change) x (1) (2 air changes) x (3) $\frac{}{7} \div 4 = 1.75$ Round to 1.8 (3) Enter District Heating Factor from page 1A. (4) Multiply these factors by 0.02 BTU/Cu.Ft./1°F to determine Required Heating Units. (5) In a similar manner, determine Potential Heating Units based on Draft Index =1. (6) Subtract to determine Potential Heating Savings, and enter on bottom line.		C-42

(Lesson continued on page 32)

Chart C - 42 (Form To Be Completed During Lesson)

(2) On pages 2 thru 7, calculate the heat loss by Infiltration and by Conduction thru the separate parts of the building, and enter the results in the table at the bottom of each page, and in the Summary Table on page 8.

HEAT LOSS BY INFILTRATION

Volume of Air in building

Floor Area

924 sq.ft.

X

8 ft.

Height to ceiling (to upstairs ceiling in two-story house)

=

HOUSE DRAFT INDEX: Opposite each of the four component parts of a building in the table below, place a check mark in the circle adjacent to the features which best describe the condition of the building.

BUILDING COMPONENT	ONE Air Change Per Hour (1)	TWO Air Change Per Hour (2)	THREE Air Change Per Hour (3)
CELLAR or CRAWL SPACE	Tight, no cracks, caulked sills, sealed cellar windows, no grade entrance leaks ○ / Plywood floor, no trap door leaks, no leaks around water, sewer and electrical openings	Some foundation cracks, no weather stripping on cellar windows, grade entrance not tight ✓ / Tongue and groove board floor, reasonable fit on trap doors, around pipes, etc.	Stone foundation, considerable leakage area, poor seal around grade entrance ○ / Board floor, loose fit around pipes, etc.
WINDOWS	Storm windows with good fit ✓ SOME	No storm windows, good fit on regular windows ○	No storm windows, loose fit on regular windows ○
DOORS	Good fit on storm doors ○	Loose storm doors, poor fit on inside door ✓	No storm doors loose fit on inside door ○
WALLS	Caulked windows and doors, building paper used under siding ○	Caulking in poor repair, building needs paint ✓	No indication of building paper, evident cracks around door and window frame ○

FILL IN AT JOB SITE

MULTIPLY the number of check marks in the first column by 1, the second column by 2, and the third column by 3. The Draft Index will be the sum of these products, divided by 4.

7392 cu.ft. (Volume) X 1.8 (Draft Index) X 2 (District Heating Factor) X .02 = 532 Heating Units Now Required

Potential Savings by Reducing Infiltration

It should be possible to reduce the draft index for a building to 1 (that is reduce the number of air changes to one per hour). If the draft index for this building was improved to 1, the infiltration loss would be:

7392 cu.ft. (Volume (from above)) X 1 (Draft Index) X 2 (District Heating Factor) X .02 = 296 Potential Heating Units

Subtract the potential heating units from those now required and enter here → 236

TYPE OF HEAT LOSS	HEATING UNITS REQUIRED	POTENTIAL HEATING SAVINGS	PROPOSED CHANGES TO STRUCTURE	HEATING UNITS TO BE SAVED
INFILTRATION	532	236		

PAGE 2

LESSON PLAN NO. 5B STEP No. 2 - CALCULATION

(Continued from page 30)

POINTS OF EMPHASIS	Manual Page	Chart No.
(b) JOB BOOK Page 3: Heat Losses by Conduction Through Floors (1) Enter Floor Area from page 1 (2) Select appropriate Floor Exposure Factor (3) From Table 1 on page 12, obtain the "R" value for each material in the floor. Add these "R" values to obtain composite "R" value for floor. Round off value to nearest tenth of unit. (4) Enter District Heating Factor from page 1A (5) Use these factors to determine the Required Heating Units and enter on bottom line. (6) In a similar manner determine Potential Heating Units based on Floor Exposure Factor = 0.5. (7) Subtract to determine Potential Heating Savings, and enter on bottom line. • (Lesson continued on page 34)		C-43

Chart C - 43 (Form To Be Completed During Lesson)

HEAT LOSSES BY CONDUCTION THROUGH FLOORS

Floor Exposure Factor

Select the appropriate factor from the descriptions below:

☐ Building on posts or pillars with no skirts below floor	1.0
☐ Crawl space skirted	0.8
☐ Rock wall basement	0.8
☒ More than two feet of basement wall exposed above grade	0.8
☐ Building on slab	0.5
☐ Building with tight crawl space	0.5
☐ Building with tight basement (heated or unheated)	0.5

'R' Value of Floor

List below all materials in floor deck, including carpet but neglecting floor joists, starting from inside surface and working down.

Insert 'R' value for each component from Table I

Material	Thickness	'R' Value
Interior Surface	---	.68
LINOLEUM		.08
PLYWOOD	1/2"	.65
SUB-FLOOR	5/8"	1.00
Interior Surface	---	.68

FILL IN AT JOB SITE

924 sq.ft. (Floor Area (from Building Description)) X 0.8 (Floor Exposure Factor) X 2 (District Heating Factor) ÷ 3.1 (Total 'R' Value) = 477 (Heating Units Required)

Potential Savings on Floor Heat Losses

Floors can sometimes be insulated to reduce heat loss but this is often difficult, and where water pipes are below the floor may cause freezing problems during very cold spells. However, every floor should be protected from drafts, etc., so that it has a floor exposure factor of 0.5. With this exposure factor for this building, the heat loss through the floor would be:

924 sq.ft. (Floor Area From Above) X 0.5 (Floor Exposure Factor) X 2 (District Heating Factor) ÷ 3.1 ('R' Value from Above) = 299 (Potential Heating Units)

Subtract the potential heating units from those now required and Enter Here → 178 (Potential Heating Savings)

TYPE OF HEAT LOSS	HEATING UNITS REQUIRED	POTENTIAL HEATING SAVINGS	PROPOSED CHANGES TO STRUCTURE	HEATING UNITS TO BE SAVED
CONDUCTION THRU: FLOORS	477	178		

PAGE 3

(Continued from page 32)

POINTS OF EMPHASIS	Manual Page	Chart No.
(c) JOB BOOK Page 4: Heat Losses by Conduction Through Ceilings (1) Insert Ceiling Area (normally same as Floor Area on page 1). (2) From Table 1 on page 12 of JOB BOOK, obtain "R" value for each material in the ceiling (or roof, where appropriate). Add these "R" values to obtain composite "R" value for ceiling (or roof). Round off value to nearest tenth of unit. (3) Enter District Heating Factor from page 1A. (4) Use these factors to determine the Required Heating Units and enter on bottom line. (5) In a similar manner, determine Potential Heating Units based upon an "R" value of well-insulated ceiling equal to 20. (6) Subtract to determine Potential Heating Savings, and enter on bottom line. (Lesson continued on page 36)		C-44

Chart C - 44 (Form To Be Completed During Lesson)

HEAT LOSSES BY CONDUCTION THROUGH CEILINGS

Area of Ceiling

(Take area of upstairs ceiling in a two-story house)

Ceiling area will normally be the same as floor area (from building description sheet)

Material	Thickness	'R' Value
Inside Surface	—	.68
GYPSUM BOARD	3/8"	.32
FIBERGLASS	2"	7.40
Inside Surface (.68) — OR — Outside Surface (.17)	—	.68

Distance between joists/rafters: 16"

FILL IN AT JOB SITE

924 sq.ft. (Ceiling Area) X 2 (District Heating Factor) ÷ 9.1 (Total 'R' Value) = 203 (Heating Units Required)

Potential Savings by Insulation of Ceilings

A well insulated ceiling (with 6 inches of insulation) should have an 'R' value of 20. If this was so for this building, the ceiling heat loss would be:

924 sq.ft. (Ceiling Area) X 2 (District Heating Factor) ÷ 20 ('R' Value) = 93 (Potential Heating Units)

Subtract the potential heating units from those now required and Enter Here → 110 (Potential Heating Savings)

TYPE OF HEAT LOSS	HEATING UNITS REQUIRED	POTENTIAL HEATING SAVINGS	PROPOSED CHANGES TO STRUCTURE	HEATING UNITS TO BE SAVED
CONDUCTION THRU: CEILINGS	203	110		

PAGE 4

(Continued from page 34)

POINTS OF EMPHASIS	Manual Page	Chart No.
(d) JOB BOOK Page 5: Conduction Through Single-Glass Windows		C-45
(1) Use sketches on page 1 to fill in table to determine Total Area of Single-Glass Windows.		
(2) Enter District Heating Factor from page 1.		
(3) Use these factors to determine the Required Heating Units (based upon R = 1), and enter on bottom line.		
(4) Determine the Potential Heating Savings as instructed, and enter on bottom line.		

(Lesson continued on page 38)

Chart C - 45 (Form To Be Completed During Lesson)

HEAT LOSSES BY CONDUCTION THROUGH SINGLE GLASS WINDOWS
(Assuming R = 1 for single glass)

Area of Single Glass Windows:

If none, enter 0 and go to next sheet on double windows and doors

Width	x Height	x Number	= Area
5	4	1	20
3	4	4	48

TOTAL 68 sq.ft. X 2 (District Heating Factor) = 136 (Heating Units Required)

Potential Saving by Double Glazing

Double glazing or adding storm windows will cut the heat loss by half, so divide heating units by two, and Enter Here → 68 (Potential Heating Savings)

TYPE OF HEAT LOSS	HEATING UNITS REQUIRED	POTENTIAL HEATING SAVINGS	PROPOSED CHANGES TO STRUCTURE	HEATING UNITS TO BE SAVED
CONDUCTION THRU: SINGLE-GLASS WINDOWS	136	68		

PAGE 5

(Continued from page 36)

POINTS OF EMPHASIS	Manual Page	Chart No.
(e) JOB BOOK Page 6: Heat Losses by Conduction Through Double-Glass or Plastic Covered Windows and Through Doors		C-46
(1) Use sketches on page 1 to fill in table to determine Total Area of Outside Doors and Double-Glass Windows.		
(2) Enter District Heating Factor from page 1.		
(3) Use these factors to determine Required Heating Units based upon R = 2, and enter on bottom line.		
(4) Potential Heating Savings will be "0" unless you triple glaze. Enter appropriate figure on bottom line.		
(Lesson continued on page 40)		

Chart C - 46 (Form To Be Completed During Lesson)

HEAT LOSSES BY CONDUCTION THROUGH DOUBLE GLASS OR PLASTIC COVERED WINDOWS AND THROUGH DOORS

(Assuming R = 2 for these units)

Area of Double Glass and Doors

Width	x Height	x Number	= Area
3	7	2	42
6	4	1	24
3	4	2	24

TOTAL 90 sq.ft X 2 (District Heating Factor) ÷ 2 ('R' Value) = 90 (Heating Units Required)

Potential Savings

Triple glazing of windows can be done but is not usually practical. If no change is made in the windows, the Potential Saving will be 0 heating units and should be entered here → 0 (Potential Heating Savings)

(If windows are triple glazed, the "R" value will be approx. 3 and the Potential Savings will be one-third of the "Heating Units Required.")

TYPE OF HEAT LOSS	HEATING UNITS REQUIRED	POTENTIAL HEATING SAVINGS	PROPOSED CHANGES TO STRUCTURE	HEATING UNITS TO BE SAVED
CONDUCTION THRU: DOORS & DOUBLE-GLASS WINDOWS	90	0		

PAGE 6

POINTS OF EMPHASIS	Manual Page	Chart No.
(f) JOB BOOK Page 7: Heat Losses by Conduction Through Walls		C-47
(1) Enter Perimeter and Height of Outside Walls from page 1. Multiply to obtain Gross Wall Area. Subtract sum of areas of windows and doors from pages 5 and 6 to determine Net Wall Area.		
(2) Insert District Heating Factor from page 1.		
(3) From Table 1 on page 12 of Job Book, obtain "R" value for each material in walls. Add these "R" values to obtain composite value for the walls. Round off to nearest tenth of unit.		
(4) Use these factors to determine the Required Heating Units, and enter on bottom line.		
(5) In a similar manner, determine Potential Heating Units based upon an "R" value of well-insulated walls equal to 15.		
(6) Subtract to determine Potential Heating Savings, and enter on bottom line.		
End of Lesson No. 5B (Lesson No. 5C starts on page 42)		

Chart C - 47 (Form To Be Completed During Lesson)

HEAT LOSSES BY CONDUCTION THROUGH WALLS

Total Perimeter of Outside Wall: 122 ft.

×

Total Height of Outside Wall: 8 ft.

=

Gross Wall Area: 976 sq.ft.

−

Total Area of all Windows and Doors (from previous two pages): 158 sq.ft.

=

Net Wall Area: 818 sq.ft. × 2 (District Heating Factor) ÷ 11.0 (Total 'R' Value) = 148 (Heating Units Required)

'R' Value of Outside Walls

List below all materials in walls, starting from inside and including air spaces within the wall. Insert 'R' value for each component from Table I.

Material	Thickness	'R' Value
Inside surface	---	.68
GYPSUM BOARD	3/8"	.32
AIR SPACE	3/4"	.91
FIBERGLASS	2"	7.40
AIR SPACE	3/4"	.41
SHEATHING	5/8"	1.00
ASBESTOS SHINGLES	1/4"	.13
Outside surface	---	.17

FILL IN AT JOB SITE

Potential Savings by Insulation

Well insulated walls should have an 'R' value of 15. If this was so for this building, the wall heat loss would be:

818 (Net Wall Area from box above) × 2 (District Heating Factor) ÷ 15 ('R' Value) = 109 (Potential Heating Units)

Subtract the potential heating units from those now required and Enter Here..... 39 (Potential Heating Savings)

TYPE OF HEAT LOSS	HEATING UNITS REQUIRED	POTENTIAL HEATING SAVINGS	PROPOSED CHANGES TO STRUCTURE	HEATING UNITS TO BE SAVED
CONDUCTION THRU: WALLS	148	39		

Page 7

LESSON PLAN NO. 5C Step 3 - EVALUATION

	POINTS OF EMPHASIS	Manual Page	Chart No.
1.	STEP 3 - EVALUATION OF THE DATA	12	C-48
	(a) Fill out the Summary Table on page 8 by entering the "Heating Units Required" and the Potential Heating Savings" from the corresponding tables at the bottom of pages 2 through 7.		C-49
	(b) Review the 12-point check list on pages 11 and 12 of the Manual to determine the most logical and practical winterizing measures.	11-12	
	(Lesson continued on page 44)		

Chart C - 48

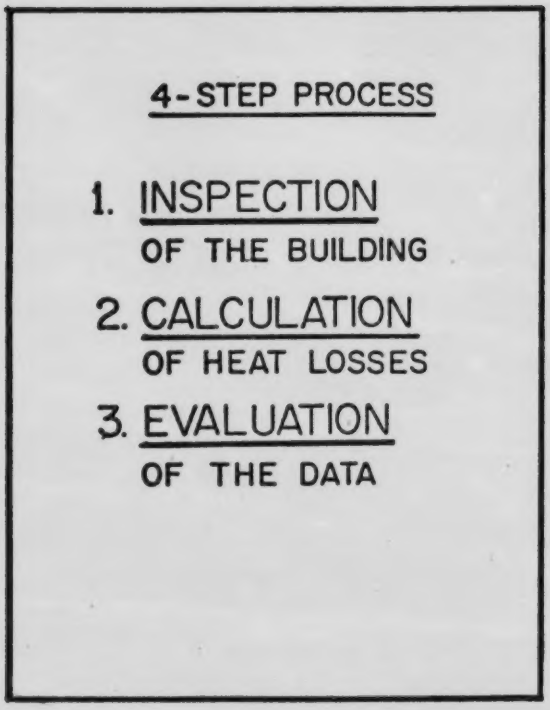


Chart C - 49 (Form To Be Completed During Lesson)

③ Use the instructions on page 11 of the FEA Winterization Manual to assess which potential savings can be obtained most successfully.

④ Fill out the following Summary Table by entering the "Heating Units Required" and the "Potential Heating Savings" from the corresponding tables at the bottom of pages 2 through 7. Then, write in the "Proposed Changes" and "Heating Units to be Saved" by such changes.

HEAT REQUIREMENT ESTIMATES (Annual Heating Units Needed)

TYPE OF HEAT LOSS		HEATING UNITS REQUIRED	POTENTIAL HEATING SAVINGS	PROPOSED CHANGES TO STRUCTURE	HEATING UNITS TO BE SAVED
INFILTRATION	From Page 2	532	236	CAULK & WEATHERSTRIP ALL DOORS & WINDOWS	236
CONDUCTION THRU: FLOORS	Page 3	477	178	CAULK BASEMENT BANK WALL	178
CONDUCTION THRU: CEILINGS	Page 4	203	110	ADD 4" INSULATION	110
CONDUCTION THRU: SINGLE-GLASS WINDOWS	Page 5	136	68	ADD PLASTIC STORM WINDOWS	68
CONDUCTION THRU: DOORS & DOUBLE-GLASS WINDOWS	Page 6	90	0	NONE	0
CONDUCTION THRU: WALLS	Page 7	142	39	NONE - WALLS CLOSED	0
	TOTALS	1580	631		592

⑤ Use the space below to calculate the quantities and cost of materials needed to make the proposed changes to the building.

INSULATION
CEILING - 924 sq ft - ORDER 1000 sq. ft.

PLASTIC STORM WINDOWS
5' WIDE PLASTIC 4 = 8' = 12'
1 x 5' = 5'/17' - ORDER 20' + TAPE

BANKING
4' WIDE PLASTIC 33' + 28' + 33' = 94' - ORDER 100' + TAPE

WEATHERSTRIP
2 DOORS - 7' x 3' 17' EACH x 2 = 34' ORDER 35'

CAULK
AROUND 8 WINDOWS & 2 DOORS = 122' + BASEMENT - ORDER 5 TUBES

⑥ Fill in job sheet on opposite page.

PAGE 8

(Continued from page 42)

POINTS OF EMPHASIS	Manual Page	Chart No.
(c) Enter these "Proposed Changes" and "Heating Units To Be Saved" in the Summary Table on page 8, and add up the three columns of figures.		(C-49)
(d) Use the lower half of page 8 to calculate the quantities and cost of materials needed to make the "Proposed Changes to Structure" which you have specified in the Summary Table.		
(e) Fill Out "Job Sheet A" on page 9. (Insert carbon paper under table at top of page)		C-50
(1) Enter the Type, Quantity, Cost and Location for each item to be ordered. Enter Installation Diagram No. from Manual, as well as any Special Instructions regarding tools or methods.		
(2) Remove Job Sheet A from Job Book by tearing along perforated line at left edge of page.		

(Lesson continued on page 46)

Chart C - 50 (Form To Be Completed During Lesson)

JOB SHEET A

THIS PAGE IS REMOVABLE FOR USE AT JOB SITE

Name MARY PERKINS

Address 3 PINE STREET BANGOR, ME

Type of Materials	Quantity Required	Estimated Cost	Location Where Materials Are To Be Installed (Walls, Ceiling, etc.)	Installation Diagram No.	Special Instructions
4" INSULATION 16"- W/O VB	1000 SQ FT	70.00	CEILING	I-3	TAKE SHEARS & STEPLADDER
POLYETHYLENE 4 MIL. - 4' WIDE	100 FT.	16.00	BANKING	B-1	
POLY. 4 MIL. 5' WIDE	20 FT.	4.00	WINDOWS	P-1	NEED KNIFE & STAPLER
2" MASKING TAPE	3 ROLLS	6.00	BANKING & WINDOWS	B-1 & P-1	
CAULKING COMPOUND	6 TUBES	6.00	WINDOW & DOOR FRAMES	C-1	NEED CAULKING GUN.
WEATHER STRIP VINYL TUBING	35 FT	3.00	DOORS	S-2 & S-4	NEED HAMMER

(INSERT CARBON PAPER UNDER TABLE AT TOP OF PAGE ONLY)

Map or directions for locating home:

ROUTE 222 FROM CENTER OF TOWN 1.5 MILES

FIRST HOUSE ON LEFT AFTER CROSSING BRIDGE

FILL IN AT JOB SITE

WORK RECORD

Activity	Date	Supervisor	Comments
Order Materials	5/10/75	E. Hall	All Materials Ordered
Install Materials	6/1/75	S. Paul	Doors Not Weatherstripped

PAGE 9

(Continued from page 44)

POINTS OF EMPHASIS	Manual Page	Chart No.
(f) Fill out lower half of Job Sheet on page 10		C-51
(1) Determine estimated Total Cost of materials used.		
(2) Enter Fuel Factor based upon information from page 1A.		
(3) Enter Heating Units Saved based upon the actual changes to structure.		
(4) Enter Price of Fuel from page 1A.		
(5) Calculate Pay-Off Time. It should be less than three seasons. If it is not, check back to the most expensive changes to determine if they are really worth the expense.		
End of Lesson No. 5C (Lesson No. 5D starts on page 48)		

Chart C - 51 (Form To Be Completed During Lesson)

JOB SHEET B

THIS PAGE IS RETAINED WITH JOB BOOK AS PERMANENT RECORD

Type of Materials	Quantity Required	Estimated Cost	Location Where Materials Are To Be Installed (Walls, Ceiling, Etc.)	Installation Diagram No.	Special Instructions
4" INSULATION 16" c/c R.B.	1008 SQFT	70.00	CEILING	I-3	TAKE SHEERS & STEPLADDER
POLYETHYLENE 4 MIL = 4' WIDE	100 FT	16.00	BANKING	B-1	
POLY. 4 MIL. 6' WIDE	20 FT	4.00	WINDOWS	P-1	NEED KNIFE & STAPLER
2" MASKING TAPE	3 ROLLS	6.00	BANKING & WINDOWS	B-1 & P-1	
CAULKING COMPOUND	6 TUBES	6.00	WINDOW & DOOR FRAMES	C-1	NEED CAULKING GUN
WEATHER STRIP VINYL TUBING	35 FT	3.00	DOORS	S-2 & J-4	NEED HAMMER
		Total Cost	105.00		

(7) PAY-OFF TIME

This is the number of seasons for fuel savings to pay off the cost of winterization.

105.00
Total Cost (from job sheet above)

=

.44 YRS.
"Pay-off" Time (seasons)

GOOD INVESTMENT!

1 (Fuel Factor: Fuel Oil = 1, Natural Gas = 120, Electricity = 30) X 592 (Total Heating Units Saved (From page 8)) X .40 (Price of Fuel Per gal, cu.ft., KWH)

PAGE 10

LESSON PLAN NO. 5C STEP 3 - EVALUATION

(Continued from page 46)

	POINTS OF EMPHASIS	Manual Page	Chart No.
2.	Final step in the winterization process is INSTALLATION of Materials. Some members of class may be well versed in this activity. Everyone will benefit by pooling our knowledge of the techniques that have proved to be most effective. Method we will use to cover the highlights of this subject will be:_____ (NOTE TO TEACHER - Refer to following page for suggested methods for Lesson 5D).	13	C-52

End of Lesson 5C (Lesson 5D starts on next page)

Chart C - 52

4-STEP PROCESS

1. INSPECTION OF THE BUILDING
2. CALCULATION OF HEAT LOSSES
3. EVALUATION OF THE DATA
4. INSTALLATION OF THE MATERIALS

Chart C - 53

TYPICAL COST OF MATERIALS

Material	Type	Unit Size	Unit Cost	Local Vendor	Date
Mineral Wool	16" Batt	S ft.			
" "	Loose	Cu. ft.			
Storm Window	Glass				
"	Plastic film				
Weatherstrip					
Caulking					
Strapping					
Heating Oil		Gal			
Electricity		KWH			
Natural Gas		Cu. ft.			
Bottled Gas					
Kerosene		Gal			
Coal/Coke		Ton			
Wood		Cord			

NOTE TO TEACHER

1. This subject, Installation of Materials, does not lend itself as well to the lecture method of instruction which was used in the previous lessons. The following methods which involve either laboratory exercises or classroom demonstrations are suggested for consideration by the teacher in preparing a Lesson Plan:

   (a) Laboratory Exercises (Preferred Method)
   The laboratory exercises which begin on the following page represent the most effective method for teaching this subject to a class of students who have had some training and/or experience in carpentry.

   (b) Classroom Demonstration (Alternative Method)
   If shop facilities are not available, the teacher may wish to conduct demonstrations in a classroom of the installation activities covered in the laboratory exercises.

   (c) Classroom Lecture (Optional)
   An Optional Lesson Plan on Installation, which utilizes approximately sixty 35mm slides, has been prepared for use when classroom facilities are not suitable for either laboratory exercises or classroom demonstrations. Several sets have been distributed to the State Energy Office in each state for use in the vocational-technical schools. In addition, a set is available on a loan basis from the Regional Office of the Federal Energy Administration.

2. LABORATORY EXERCISE ON INSTALLING INSULATION

   (a) Objective: to give the students a hands-on experience in installing the common forms of insulation materials.

   (b) Equipment and Materials Required:
   Wall frame mock-up
   Insulation (blanket or batt)

(Lesson continued on next page)

(Continued from previous page)

	NOTE TO TEACHER
	(b) Equipment and Materials Required (continued) Stapler Shears (c) Suggested Procedure Demonstrate to class the proper methods for installing insulation in ceilings, floors, crawl spaces and masonry walls. Discuss vapor barriers and ventilating attics. Have students (or teams) practice installing insulation on the wall frame mock-ups. (If small staples are used, the insulation can be carefully removed and reused).
3.	LABORATORY EXERCISE ON INSTALLING WEATHER STRIPPING (a) Objective: to give the students a hands-on experience in installing weather stripping and other weatherizing materials. (b) Equipment and Materials Required Door and frame mock-up Weather stripping materials (several types) Caulking gun and tube Shears Knife Hammer Stapler (c) Suggested Procedure Discuss the selection of materials. Demonstrate to class the proper method for installing the materials. Have the students (or teams) practice installing the wealtherizing materials to the mock-ups. (Lesson continued on next page)

(Continued from previous page)

NOTE TO TEACHER	
4.	LABORATORY EXERCISE ON INSTALLING PLASTIC STORM WINDOWS (a) Objective: to give the students a hands-on experience in installing plastic storm window. (b) Equipment and Materials Required: Window frame mock-up Plastic sheeting Fastening materials: Wood strapping and nails Masking tape and staples Tools: Shears, knife, hammer, saw, and stapler (c) Suggested Procedure Discuss the procedure, demonstrate to class and have students (or teams) practice installing plastic on window frame mock-up.
5.	FIELD ASSIGNMENT TO OBTAIN COSTS OF MATERIALS Teacher should encourage students to phone or visit local suppliers to obtain current costs of common materials used in the winterizing process. A table for recording this information is provided in the student's Manual on page 27 (chart C-53). End Of Lesson 5D

NOTE TO TEACHER

1. PURPOSE OF LESSON
This lesson will enable the Teacher to evaluate the degree to which the Instructional Objectives have been achieved.

2. EVALUATION OF INSTRUCTIONAL OBJECTIVE NO. 1 ESTIMATION

(a) Objective: Given the physical dimensions and construction features of a detached residential structure, a student will prepare (for a homeowner) a written analysis (Job Book), containing the following:

(1) Identification of gross thermal deficiencies of the structure which result in heat losses by infiltration and conduction;

(2) Comparison of current heating requirements with the potential savings;

(3) Job Write-up, from which material specifications and bill of materials will be prepared; and

(4) Bill of Materials for the feasible remedies, including costs and pay-back period.

(b) Procedure
A preferred and an alternate procedure are suggested. The preferred procedure is a field exercise that involves the Inspection-Calculation-Evaluation steps of the 4-step winterizing process covered in Lesson Plans Nos. 5A, 5B and 5C. The alternate procedure is a classroom exercise that involves the Calculation-Evaluation steps only.

(c) Field Exercise
(1) Inspection: Arrange for class to visit a nearby home with simple construction characteristics (one-story, and simple floor plan).

(Lesson continued on next page)

(Continued from previous page)

NOTE TO TEACHER	
	(c) Field Exercise (continued) Working independently,(or in assigned teams), each student will record the physical dimensions and constuction features called for in the Job Book on pages 1, 2, 3, 4, 7 and 9. (To insure uniformity, the teacher will provide the student with the dwelling and heating system information called for on page 1A.) (2) Calculation-Evaluation: After returning to the classroom, the data obtained by students will be discussed by the class to resolve differences Then, each student will independently perform the calculations and evaluation called for in steps 2 and 3, and record the answers in the Job Book. At the conclusion of the exercise, the answers will be compared and the differences discussed. (If appropriate, the Job Books will be collected by teacher for grading and/or evaluation purposes.) (d) Classroom Exercise (1) Inspection: If field trip is not practical, this step will be omitted. Teacher will prepare an example of single-family home with simple features. Students will be given the physical dimensions and contruction features called for in the Job Book on pages 1, 1A, 2, 3, 4, 7 & 9. (2) Calculation-Evaluation: Each student will independently perform the calculations and evaluation called for in Steps 2 and 3 of the 4-step winterization process, and record the answers in the Job Book. At the conclusion of the exercise, the answers will be compared and the differences discussed. (If appropriate, the Job Books will be collected by teacher for grading and/or evaluation purposes.) (Lesson continued on next page)

(Continued from previous page)

	NOTE TO TEACHER
3.	EVALUATION OF INSTRUCTIONAL OBJECTIVE NO. 2: INSTALLATION (a) Objective: Given a job write-up (Job Book) for a detached residentail structure, the student will describe and/or demonstrate to others the proper methods for installing the specified materials. (b) Procedure: Due to the wide variety of possible instructional situations, no standard procedure will be given here. An ideal procedure would be for the teacher to make arrangements thru a community services agency that is involved in winterizing homes, to have the class install the winterizing materials purchased by that agency. If this is not practical or feasible, the teacher is encouraged to design an evaluation procedure based upon the method of instruction employed in lesson 5D. End of Lesson No. 6

PUBLICATIONS ON HOME WINTERIZATION

Retrofitting Existing Housing for Energy Conservation: An Economic Analysis. Washington, D.C.: U.S. Department of Commerce in cooperation with the Federal Energy Administration, December 1974. This study examines the economic aspects of energy conservation techniques suitable for retrofitting into existing housing, including insulation, storm windows and doors, and weather stripping. The objective of this study is to determine that combination of techniques that will maximize net dollar savings in life-cycle operating costs for heating and cooling operations in existing homes, subject to specific climate conditions, fuel costs, and retrofitting costs. Available from Government Printing Office, Catalog No. C13.29/2:64 $1.35.

Insulation Manual, Homes/Apartments. Prepared by NAHB Research Foundation, Inc., Rockville, Maryland, September 1971. This 44-page manual provides complete information about insulation for residential buildings including application, comparative resistance values, weather data, and a simplified method of heating and cooling calculations. Available from National Mineral Wool Insulation Association, Inc., 382 Springfield Ave., Suite 312, Summit, New Jersey 07901, $2.00.

How to Insulate Homes for Oil Heating, OH-603. Installation procedures, vapor barriers, and ventilation are covered in detail in this 24-page pamphlet measuring 4" x 9". Available from National Mineral Wool Insulation Association, Inc., $0.25.

How To Save Money By Insulating Your Home, RI-500. Full instructions and advice on doing it yourself or hiring a contractor. Practical details on adding insulation to an existing home. Plus information on storm windows and doors, weather stripping and caulking are covered in this 24-page pamphlet measuring 4" x 9". Available from National Mineral Wool Insulation Association, Inc., $0.30.

Blowing Wool Application Manual, BW-201. Designed originally for use by new employees of insulation contractors, this 20-page pamphlet measuring 4" x 9", published in September 1970, is used generally by those interested in the techniques of installing blowing wool pneumatically. Available from National Mineral Wool Insulation Association, Inc. No charge for single copies.

Impact of Improved Thermal Performance in Conserving Energy. An analysis by NMWIA members of energy savings accomplished by insulation and storm doors and windows on a national basis over a ten year period. Published in 1972, this 8-3/4" x 11" brochure is available at no charge from the National Wool Insulation Association, Inc.

PROJECT *RETRO-TECH*

HOME

WINTERIZATION

COURSE

CHART 1

INSTRUCTIONAL OBJECTIVES

ESTIMATION

STUDENT WILL PREPARE

WRITTEN ANALYSIS CONTAINING:

(1) IDENTIFICATION OF DEFICIENCIES

(2) COMPARISON OF REQUIREMENTS/SAVINGS

(3) JOB SPECIFICATIONS

(4) BILL OF MATERIALS

INSTALLATION

STUDENT WILL:

(1) SUPERVISE APPLICATION

(2) CONDUCT POST-EVALUATION

CHART 2

HOME WINTERIZATION COURSE

LESSONS

A. INTRODUCTION TO HEAT LOSS

B. BUILDING HEAT LOSS BY CONDUCTION

C. BUILDING HEAT LOSS BY INFILTRATION

D. 4 STEPS TO HOME WINTERIZATION

CHART 3

MOST HOMES

CAN USE

MUCH LESS FUEL

WITHOUT

SACRIFICING

COMFORT

CHART 4

IT IS NOT THE

COLD

THAT COMES IN....

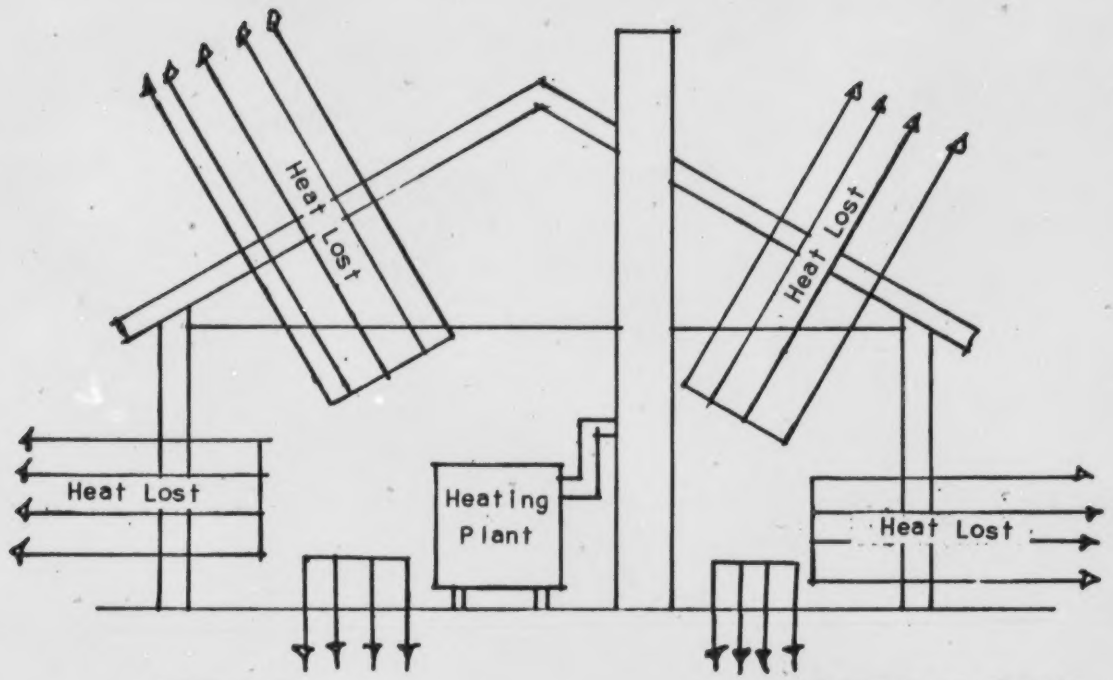
IT IS THE

HEAT WE BUY

THAT ESCAPES

TO THE OUTSIDE

CHART 5



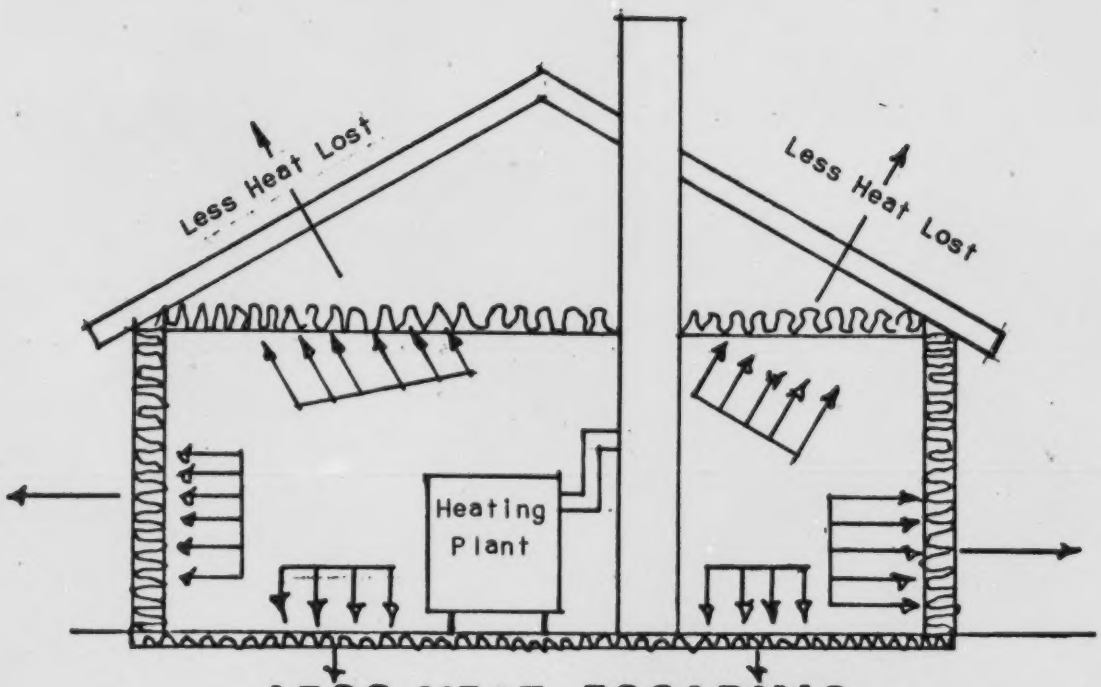
IF

HEAT GIVEN OFF BY THE HEATING PLANT = **HEAT LOSS FROM THE BUILDING**

THEN

TEMPERATURE INSIDE STAYS UP

CHART 6



LESS HEAT ESCAPING
MEANS LESS HEAT AND LESS FUEL
NEEDED TO STAY COMFORTABLE INSIDE

1 British Thermal Unit (B.T.U.)

IS

THE HEAT NEEDED TO RAISE ONE POUND OF WATER ONE DEGREE FAHRENHEIT

--- APPROXIMATELY THE HEAT GIVEN OFF BY BURNING

ONE KITCHEN MATCH

CHART 8

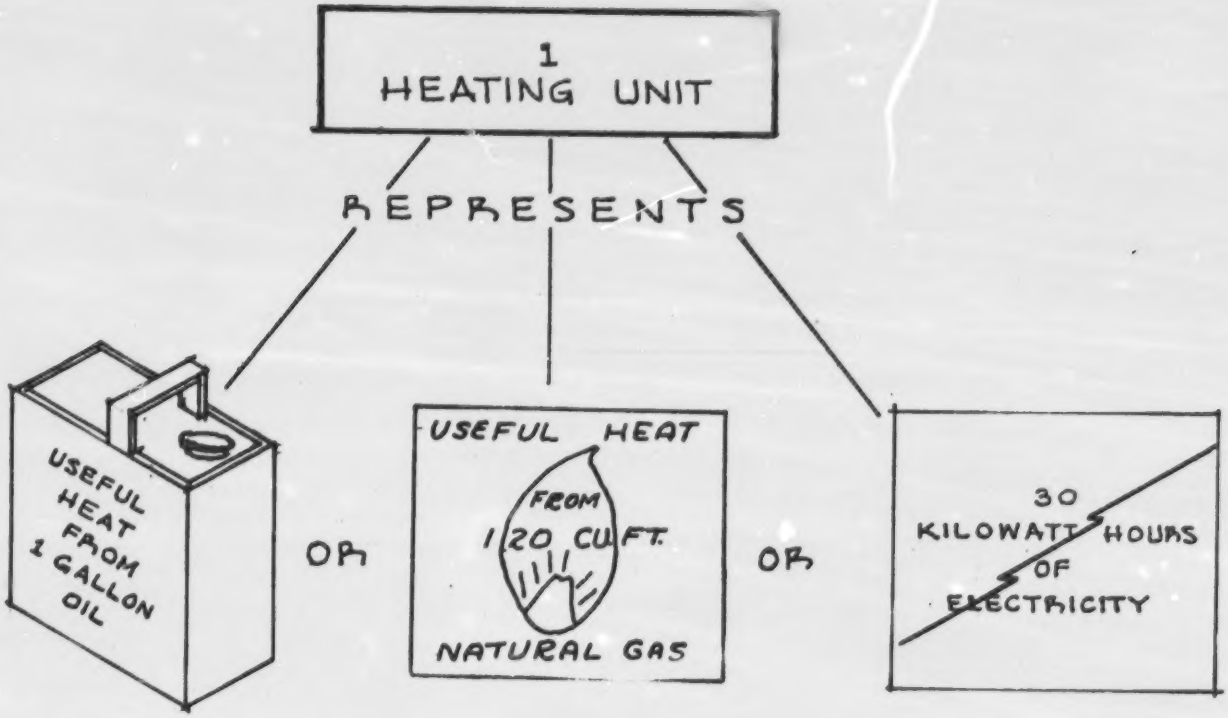

1
HEATING UNIT
REPRESENTS
USEFUL HEAT FROM 1 GALLON OIL
OR
USEFUL HEAT
FROM
120 CU FT.
NATURAL GAS
OR
30
KILOWATT HOURS
OF
ELECTRICITY

CHART 9

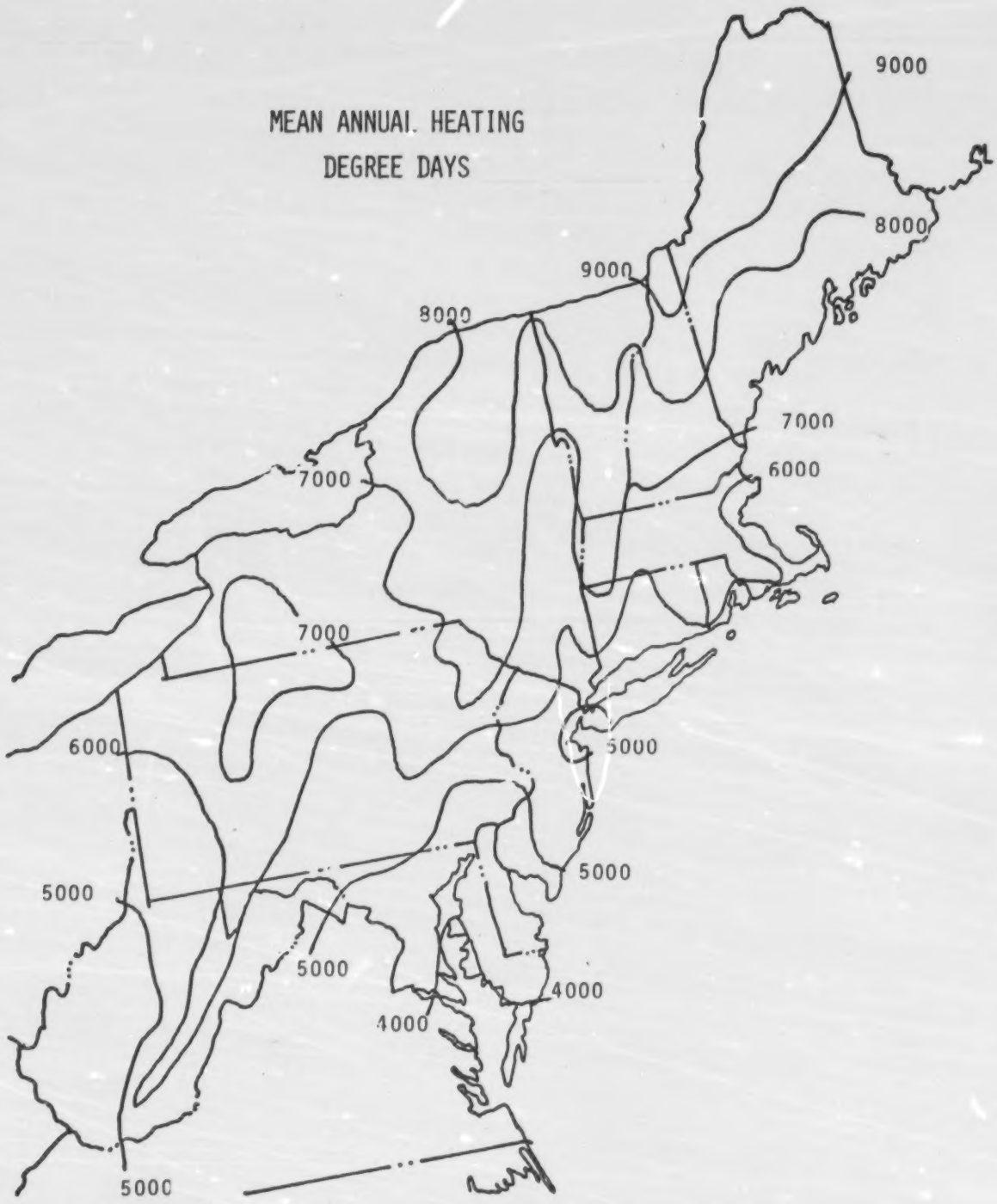

MEAN ANNUAL HEATING
DEGREE DAYS
9000
8000
9000
8000
7000
6000
7000
7000
6000
5000
5000
5000
5000
4000
4000
5000

CHART 10

IF

THE AREA HAS 4000 HEATING DEGREE DAYS __

THE DISTRICT HEATING FACTOR IS 1

CHART 11

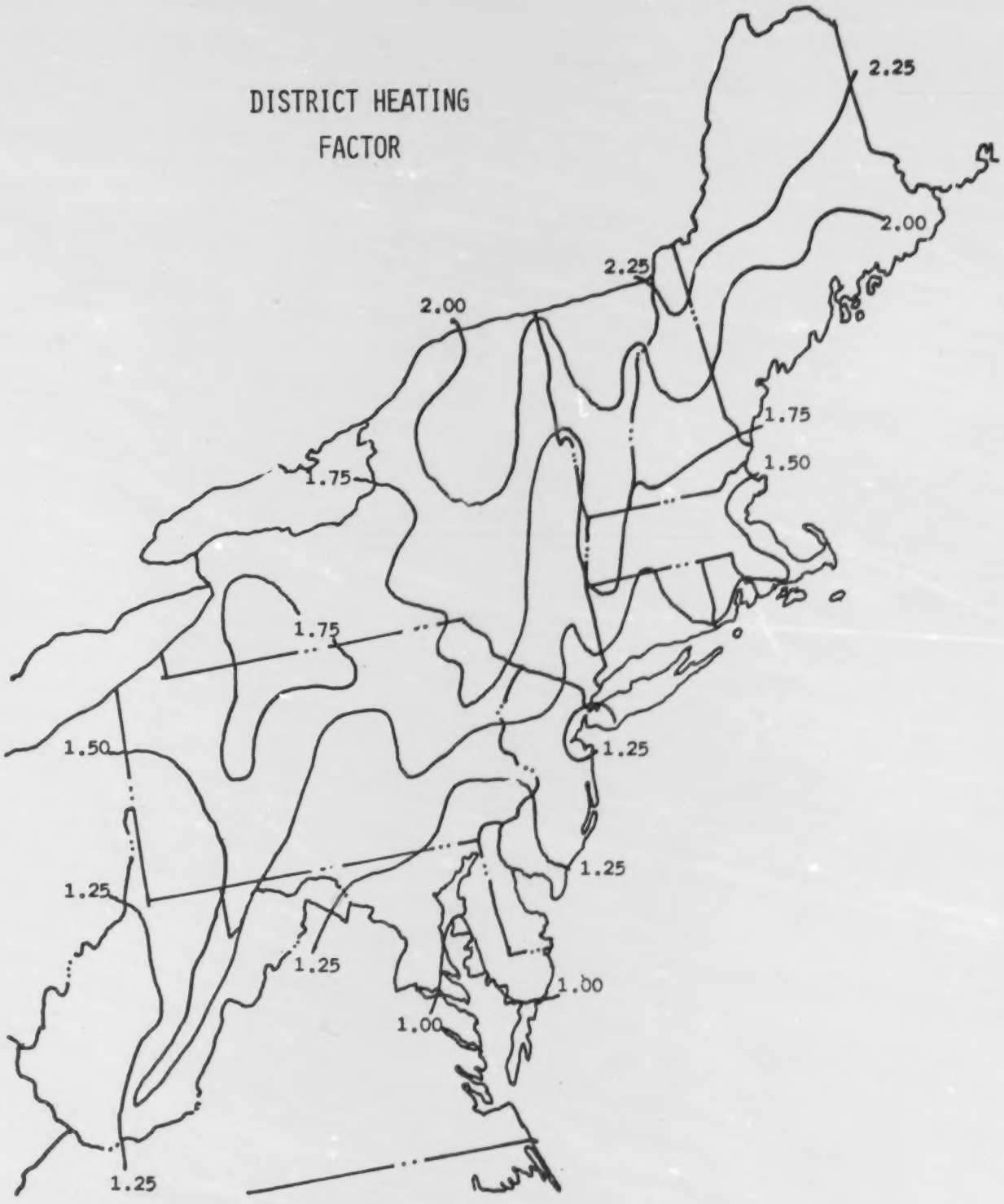

DISTRICT HEATING
FACTOR
2.25
2.00
2.25
2.00
1.75
1.50
1.75
1.75
1.50
1.25
1.25
1.25
1.25
1.00
1.00
1.25

CHART 12

HOME

WINTERIZATION

IS A

4 STEP

PROCESS

CHART 13

4-STEP PROCESS

1. INSPECTION
   OF THE BUILDING
2. CALCULATION
   OF HEAT LOSSES
3. EVALUATION
   OF THE DATA
4. INSTALLATION
   OF THE MATERIALS

CHART 14

Federal Energy
Administration

Washington
D.C.20461

Home Winterization Job Book for

Name: _____

Address: _____

_____

WORK RECORD

Assignment	Supervisor	Date Completed
HOME EVALUATION:		
Field Inspection (pg. 1-7)	_____	_____
Heat Loss Calculation (pg. 8)	_____	_____
JOB SHEET (pg. 9-10):		
Order Materials	_____	_____
Install Materials	_____	_____

CHART 15

JUNE 1975

CONDUCTION

HEAT LOST THROUGH THE EXTERIOR SURFACES

CHART 16

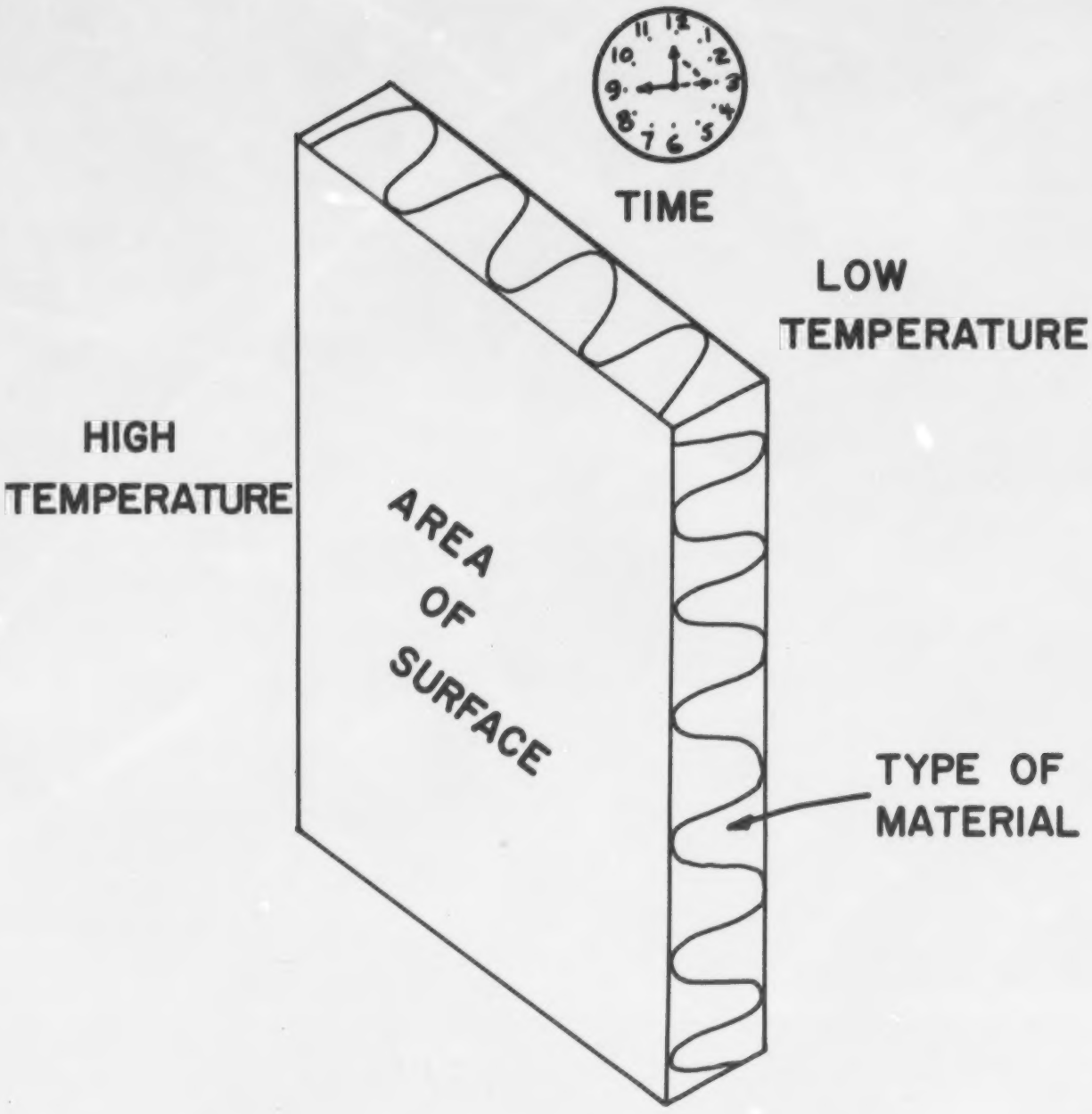

TIME
LOW
TEMPERATURE
HIGH
TEMPERATURE
AREA
OF
SURFACE
TYPE OF
MATERIAL

CHART 17

TABLE 1. INSULATION VALUE OF COMMON MATERIALS

Source: ASHRAE Guide and Data Book

MATERIAL	THICKNESS	'R' VALUE
Air Film and Spaces		
Air space, bounded by ordinary materials	3/4" or more	0.91
Air Space, bounded by aluminum foil	3/4" or more	2.17
Exterior surface resistance	- -	0.17
Interior surface resistance	- -	0.68
Masonry		
Sand and gravel concrete block	8"	1.11
Sand and gravel concrete block	12"	1.28
Lightweight concrete block	8"	2.00
Lightweight concrete block	12"	2.13
Face brick	4"	0.44
Concrete cast in place	8"	0.64
Building Materials - General		
Wood sheathing or subfloor	3/4"	1.00
Fiber board insulating sheathing	3/4"	2.10
Plywood	5/8"	0.79
Plywood	1/2"	0.63
Plywood	3/8"	0.47
Bevel lapped siding	1/2" x 8"	0.81
Bevel lapped siding	3/4" x 10"	1.05
Vertical tongue and groove board	3/4"	1.00
Drop siding	3/4"	0.94
Asbestos board	1/4"	0.13
3/8" gypsum lath and 3/8" plaster	3/4"	0.42
Gypsum board	3/8"	0.32
Interior plywood panel	1/4"	0.31
Building paper	--	0.06
Vapor barrier	--	0.00
Wood shingles	--	0.87
Asphalt shingles	--	0.44
Linoleum	--	0.08
Carpet with fiber pad	--	2.08
Hardwood floor	--	0.71
Insulation Materials (mineral wool, glass wool, wood wool, etc.)		
Blanket or batts	1"	3.70
Blanket or batts	3 1/2"	11.00
Blanket or batts	6"	19.00
Loose fill	1"	3.33
Rigid insulation board (sheathing)	3/4"	2.10
Windows and Doors		
Single window	--	Approx. 1.00
Double window	--	Approx. 2.00
Exterior door	--	Approx. 2.00

AIR FILM AND SPACES

Material	Thickness	"R" Value
Air Space, Bounded by ordinary materials	3/4" or more	0.91
Air Space, bounded by aluminum foil	3/4" or more	2.17
Exterior surface resistance	Nil	0.17
Interior surface resistance	Nil	0.68

MASONRY

Material	Thickness	"R" Value
Sand and gravel concrete block	8"	1.11
Sand and gravel concrete block	12"	1.28
Lightweight concrete block	8"	2.00
Lightweight concrete block	12"	2.13
Face brick	4"	0.44
Concrete cast in place	8"	0.64

BUILDING MATERIALS

MATERIAL	THICKNESS	"R" VALUE
WOOD SHEATHING OR SUBFLOOR.....	3/4"	1.00
FIBER BOARD INSULATING SHEATHING.....	3/4"	2.10
PLYWOOD.....	5/8"	0.79
PLYWOOD.....	1/2"	0.63
PLYWOOD.....	3/8"	0.47
BEVEL LAPPED SIDING.....	1/2" x 8"	0.81
BEVEL LAPPED SIDING.....	3/4" x 10"	1.05
VERTICAL TONGUE AND GROOVE.....	3/4"	1.00
DROP SIDING.....	3/4"	0.94
ASBESTOS BOARD.....	1/3"	0.13
3/8" GYPSUM LATH AND 3/8" PLASTER.....	3/4"	0.42
GYPSUM BOARD.....	3/8"	0.32
INTERIOR PLYWOOD PANELING.....	1/4"	0.31
BUILDING PAPER.....	--	0.06
VAPOR BARRIER.....	--	0.00
WOOD SHINGLES.....	--	0.87
ASPHALT SHINGLES.....	--	0.44
LINOLEUM.....	--	0.08
CARPET WITH FIBER PAD.....	--	2.08
HARDWOOD FLOOR.....	--	0.71

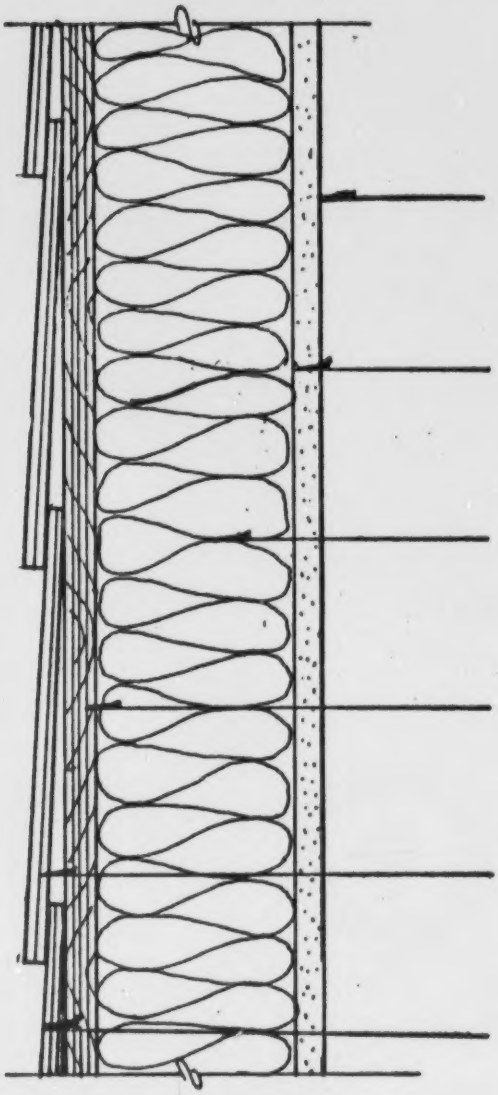
INSULATION MATERIALS

Materials	Thickness	"R" Value
Blanket or batts	1"	3.70
Blanket or batts	3-1/2"	11.00
Blanket or batts	6"	19.00
Loose fill	1"	3.35
Rigid insulation board (sheathing).....	3/4"	2.10

WINDOWS AND DOORS

To simplify calculations, use the following approximate 'R' values.

Material	"R" Value
Single window.....	1.00
Double window.....	2.00
Exterior Door.....	2.00



Interior Surface	.68
3/8" Gypsum Board	.32
3 1/2" Blanket Insulation	11.00
3/8" Plywood	.47
Bevel Siding	.81
Exterior Surface	.17
Overall R =	13.45

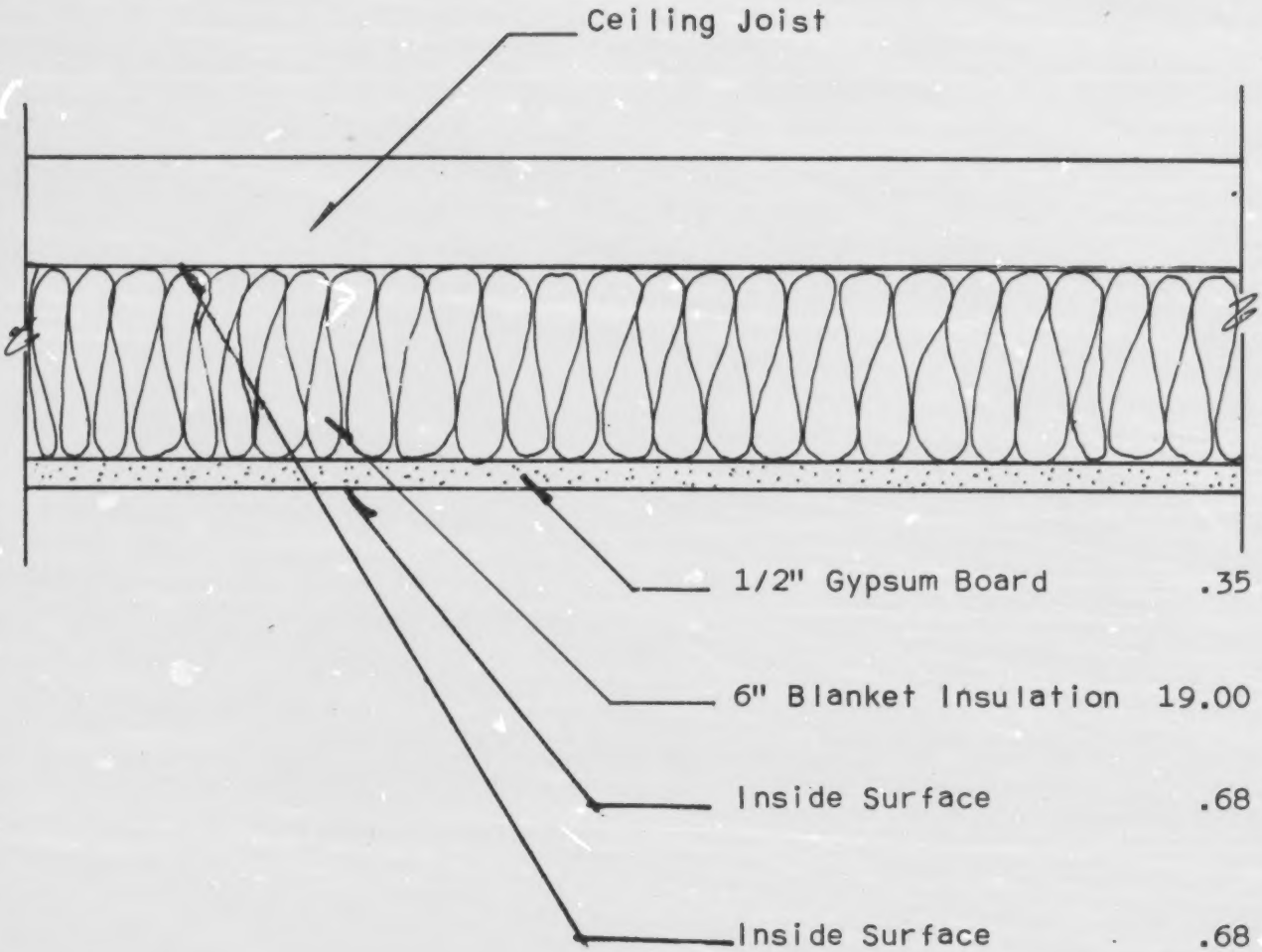
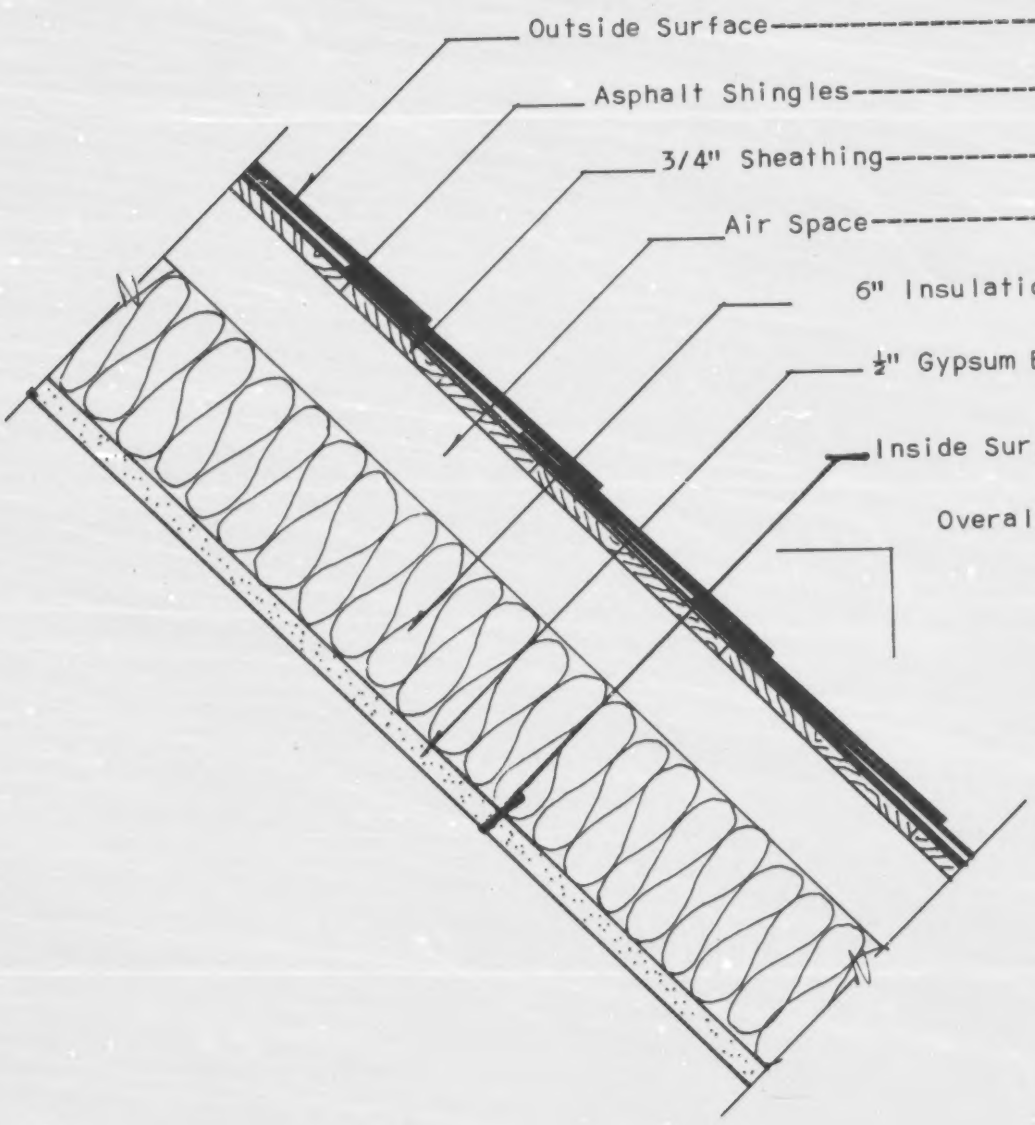

Ceiling Joist
1/2" Gypsum Board .35
6" Blanket Insulation 19.00
Inside Surface .68
Inside Surface .68
Overall R 20.71

CHART 23


Outside Surface .17
Asphalt Shingles .44
3/4" Sheathing 1.00
Air Space .91
6" Insulation 19.00
½" Gypsum Board .35
Inside Surface .68
Overall R 22.55

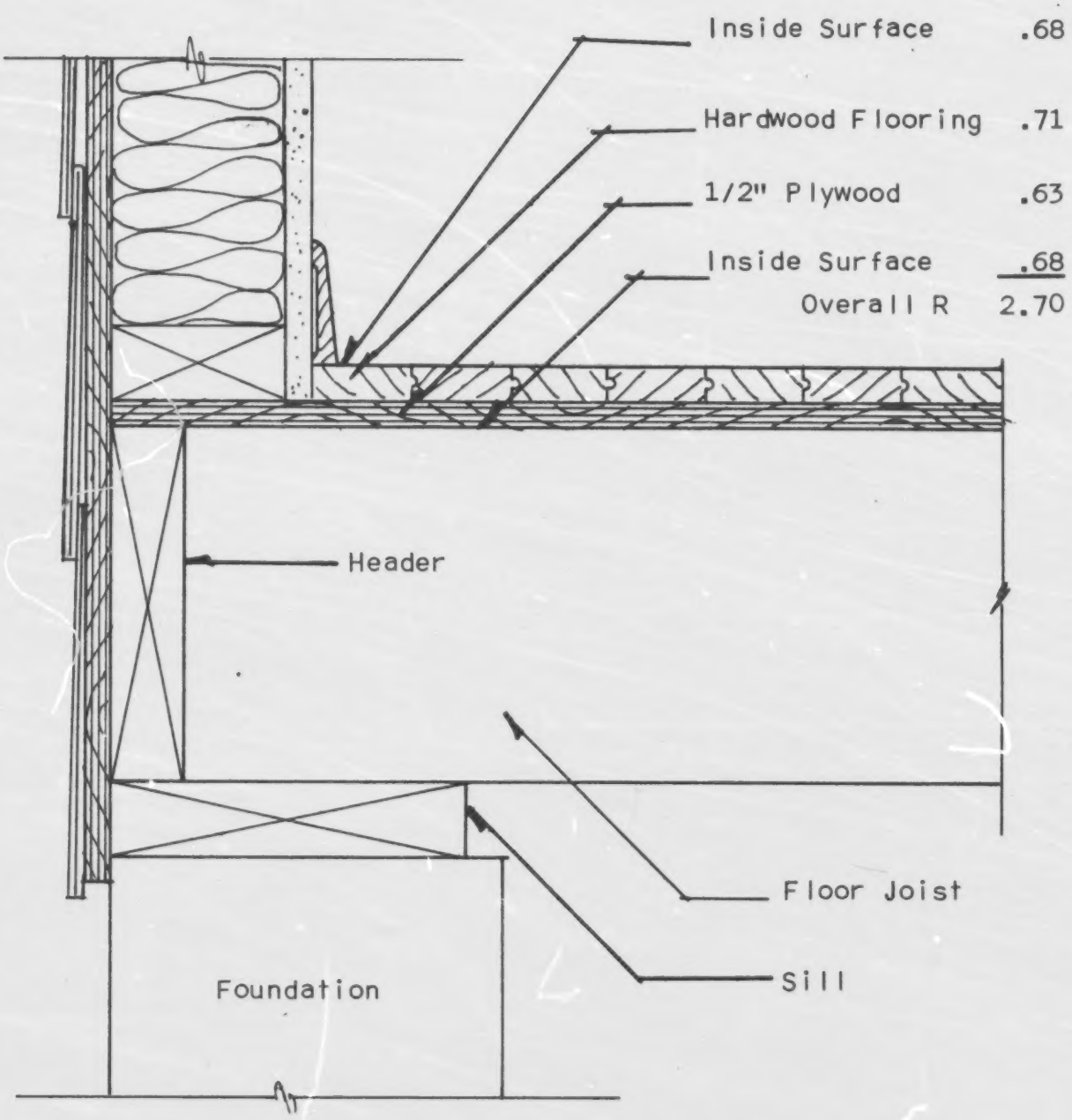

Inside Surface .68
Hardwood Flooring .71
1/2" Plywood .63
Inside Surface .68
Overall R 2.70
Header
Floor Joist
Sill
Foundation

CHART 25

OUTSIDE

0° F TEMPERATURE

50% RELATIVE HUMIDITY

.013 POUNDS PER SQUARE INCH VAPOR PRESSURE

LOW PRESSURE

INSIDE

70° F TEMPERATURE

40% RELATIVE HUMIDITY

.150 POUNDS PER SQUARE INCH VAPOR PRESSURE

HIGH PRESSURE

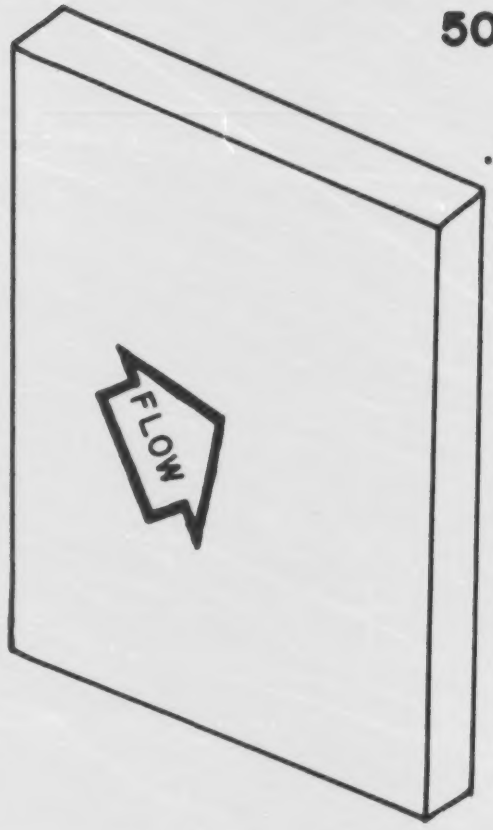


CHART 26

INFILTRATION

HEAT LOST BY:

COLD AIR
COMING IN

AND

WARM AIR
GOING OUT

CHART 27

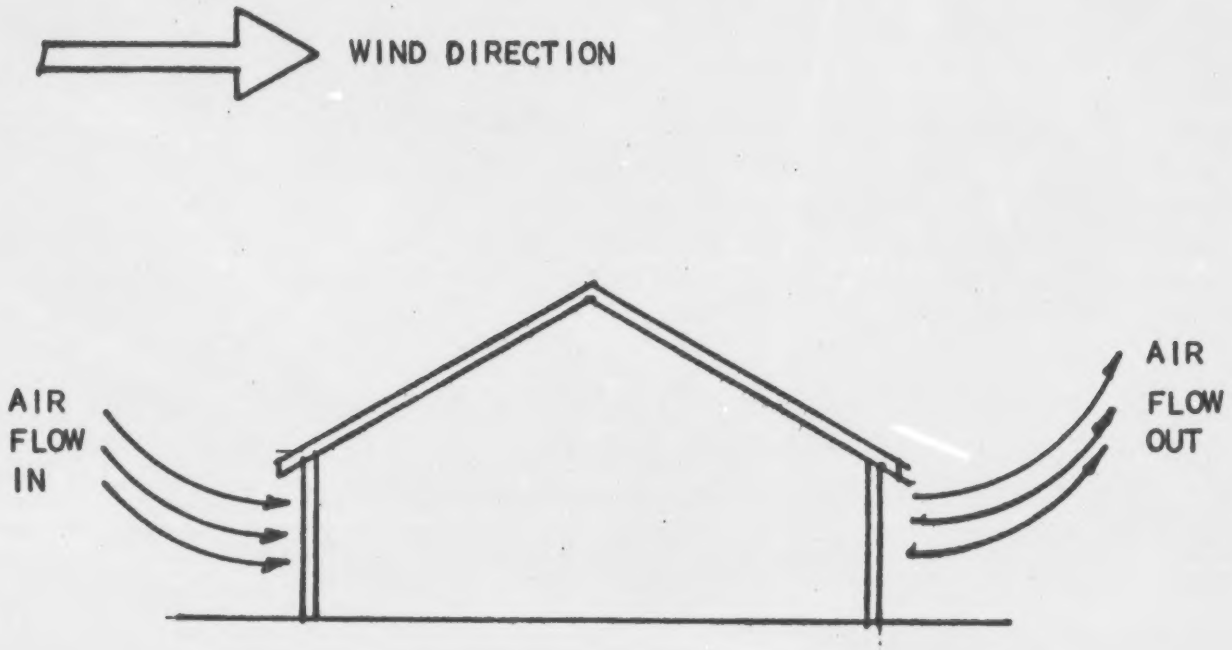


FIG. 1 - INFILTRATION BY WIND

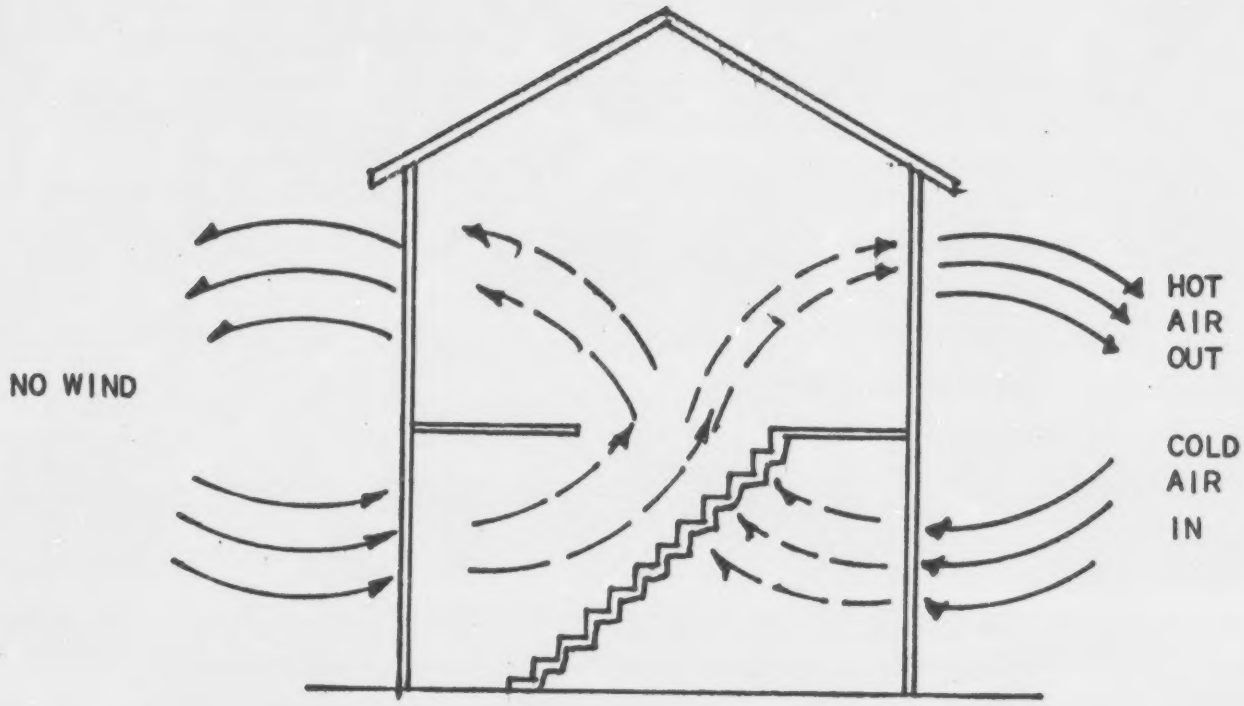


FIG. 2 - "CHIMNEY-EFFECT"

BUILDING COMPONENT	ONE Air Change Per Hour ①	TWO Air Change Per Hour ②	THREE Air Change Per Hour ③
CELLAR or CRAWL SPACE	Tight, no cracks, caulked sills, sealed cellar windows, no grade entrance leaks Plywood floor, no trap door leaks, no leaks around water, sewer and electrical openings	Some foundation cracks, no weather stripping on cellar windows, grade entrance not tight Tongue and groove board floor, reasonable fit on trap doors, around pipes, etc.	Stone foundation, considerable leakage area, poor seal around grade entrance Board floor, loose fit around pipes, etc.
WINDOWS	Storm windows with good fit	No storm windows, good fit on regular windows	No storm windows, loose fit on regular windows
DOORS	Good fit on storm doors	Loose storm doors, poor fit on inside door	No storm doors loose fit on inside door
WALLS	Caulked windows and doors, building paper used under siding	Caulking in poor repair, building needs paint	No indication of building paper, evident cracks around door and window frame

4-STEP PROCESS

1. INSPECTION OF THE BUILDING

CHART 31

10 STEPS IN BUILDING INSPECTION

1. Take overall building dimensions
   (Length, Width, Sidewall Height)
2. Measure windows (Height, Width)
3. Measure doors (Height, Width)
4. Check condition of exterior
   (Look for cracks, lack of paint, caulking)
5. Check wall construction
6. Check ceiling, roof
7. Check floor construction
8. Inspect foundation for cracks
9. Check for infiltration, feel for drafts, open outside door quickly (resistance means a tight fit)
10. Talk to the occupant

Federal Energy Administration

Washington D.C. 20461

PROJECT RETRO-TECH

Home Winterization Job Book for

Name: MARY PERKINS

Address: 3 PINE STREET
BANGOR, MAINE

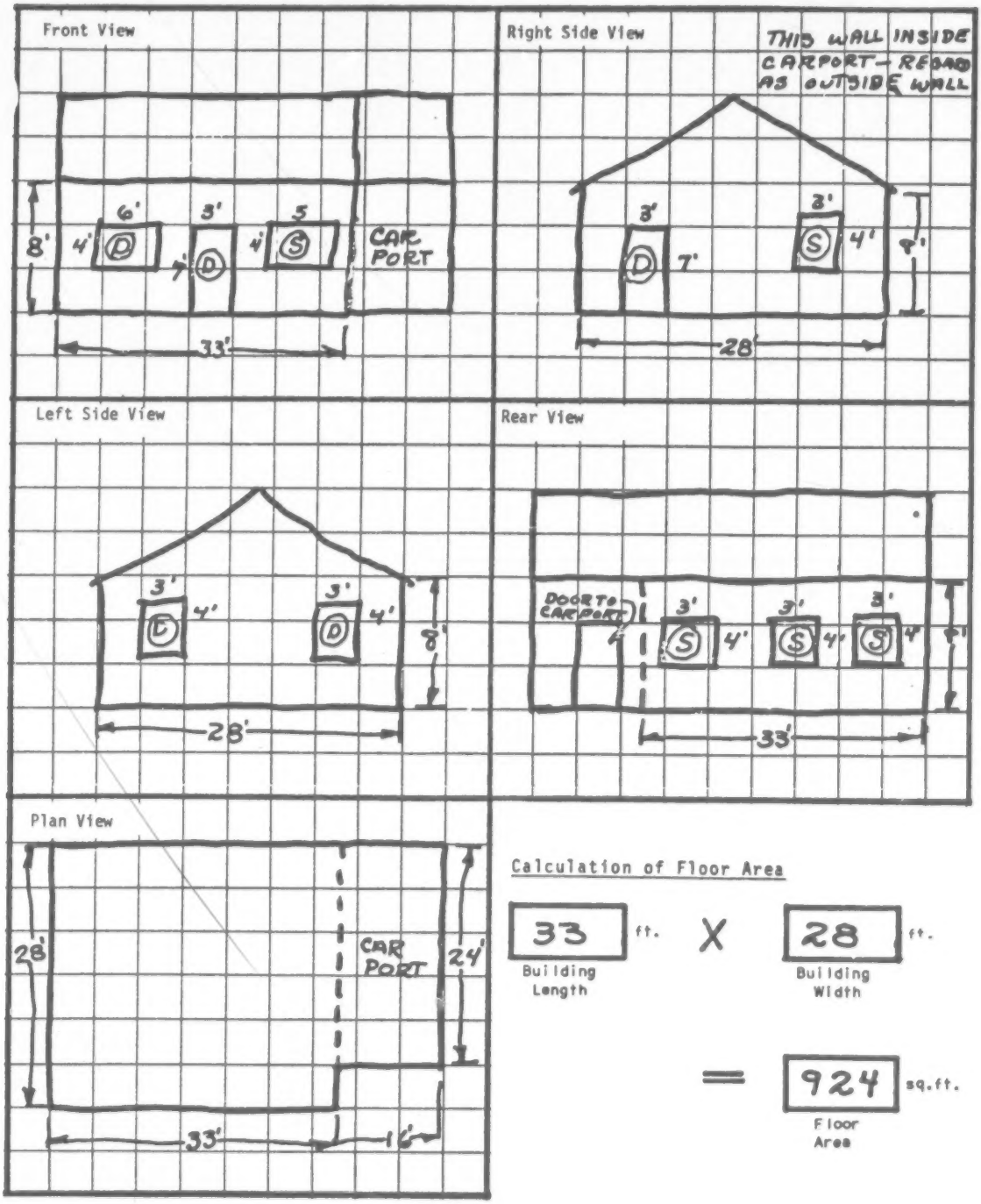
WORK RECORD

Assignment	Supervisor	Date Completed
HOME EVALUATION:		
Field Inspection (pg. 1-7)	ED. JONES	5-2-75
Heat Loss Calculation (pg. 8)		
JOB SHEET (pg. 9-10):		
Order Materials		
Install Materials		

CHART 33

DESCRIPTION OF BUILDING

1 Sketch all views and put dimensions on each part shown, e.g., length of walls, width and length of windows, etc. Label all single glass windows (S) and double glass and doors (D). Complete all items in the Job Book labeled "Fill in at Job Site."



Calculation of Floor Area

33 ft.	X	28 ft.
Building Length		Building Width

= 924 sq.ft.

Floor Area

FILL IN AT JOB SITE

DESCRIPTION OF BUILDING
(Continued from Opposite Page)

DWELLING UNIT INFORMATION

* NAME OF HEAD OF HOUSEHOLD
MARY PERKINS

* NAME & ADDRESS OF OWNER:
(if not the same as above)
MARY PERKINS
3 PINE STREET
BANGOR, MAINE

* OCCUPANTS OF STRUCTURE:
Total Number — 5

* STYLE OF STRUCTURE:
- [✓] One Story
- [ ] Split-level
- [ ] Two Story
- [ ] Other (Specify) ____
- [ ] 2 1/2 Story

* AGE OF STRUCTURE (Approx): 10 years

* ROOMS IN LIVING SPACE:
Total Number of Rooms..... 6
Number Used in Winter..... 6

* OCCUPANTS COMMENTS (e.g., drafty, cold floors, too expensive to heat, etc.):
FUEL BILLS TOO HIGH
DRAFTY WINDOWS

HEATING SYSTEM INFORMATION

* TYPE OF FUEL: (P = Primary) (S = Secondary)
- [P] Fuel Oil
- [ ] Natural Gas
- [ ] Bottled Gas
- [S] Wood
- [ ] Coal/Coke
- [ ] Kerosene
- [ ] Electricity
- [ ] Other (Specify) ____

* TYPE OF HEATING SYSTEM: (P = Primary) (S = Secondary)
- [P] Steam/Hot water/Hot Air
- [S] Fireplace/Stove/Portable Heater
- [ ] Electrical Baseboard
- [ ] Other (Specify) ____

* DOMESTIC HOT WATER:
Does central heating system provide heat for domestic hot water? NO

* THERMOSTAT SETTING IN WINTER (average):
Day 65° Night 60° None [ ]

* AMOUNT OF FUEL USED LAST HEATING SEASON:

	Primary	Supplementary
Type	FUEL OIL	WOOD
Quantity	1500GAL.	1 CORD
Total Cost	$585.00	$ 45.00

* DISTRICT HEATING FACTOR..... 2
(from Manual, page 8)

PAGE 1A

CHART 35

(2) On pages 2 thru 7, calculate the heat loss by Infiltration and by Conduction thru the separate parts of the building, and enter the results in the table at the bottom of each page, and in the Summary Table on page 8.

HEAT LOSS BY INFILTRATION

Volume of Air in building

Floor Area

[ ] sq.ft.

X

[ ] ft.

Height to ceiling (to upstairs ceiling in two-story house)

=

HOUSE DRAFT INDEX: Opposite each of the four component parts of a building in the table below, place a check mark in the circle adjacent to the features which best describe the condition of the building.

BUILDING COMPONENT	ONE Air Change Per Hour (1)	TWO Air Change Per Hour (2)	THREE Air Change Per Hour (3)
CELLAR or CRAWL SPACE	Tight, no cracks, caulked sills, sealed cellar windows, no grade entrance leaks ○ Plywood floor, no trap door leaks, no leaks around water, sewer and electrical openings	Some foundation cracks, no weather stripping on cellar windows, grade entrance not tight ✓ Tongue and groove board floor, reasonable fit on trap doors, around pipes, etc.	Stone foundation, considerable leakage area, poor seal around grade entrance ○ Board floor, loose fit around pipes, etc.
WINDOWS	Storm windows with good fit ✓ SOME	No storm windows, good fit on regular windows ○	No storm windows, loose fit on regular windows ○
DOORS	Good fit on storm doors ○	Loose storm doors, poor fit on inside door ✓	No storm doors loose fit on inside door ○
WALLS	Caulked windows and doors, building paper used under siding ○	Caulking in poor repair, building needs paint ✓	No indication of building paper, evident cracks around door and window frame ○

FILL IN AT JOB SITE

MULTIPLY the number of check marks in the first column by 1, the second column by 2, and the third column by 3. The Draft Index will be the sum of these products, divided by 4.

[ ] cu.ft. (Volume) X [ ] (Draft Index) X [ ] (District Heating Factor) X .02 = [ ] (Heating Units Now Required)

Potential Savings by Reducing Infiltration

It should be possible to reduce the draft index for a building to 1 (that is reduce the number of air changes to one per hour). If the draft index for this building was improved to 1, the infiltration loss would be:

[ ] cu.ft. (Volume (from above)) X [1] (Draft Index) X [ ] (District Heating Factor) X .02 = [ ] (Potential Heating Units)

Subtract the potential heating units from those now required and enter here → [ ]

TYPE OF HEAT LOSS	HEATING UNITS REQUIRED	POTENTIAL HEATING SAVINGS	PROPOSED CHANGES TO STRUCTURE	HEATING UNITS TO BE SAVED
INFILTRATION				

PAGE 2

HEAT LOSSES BY CONDUCTION THROUGH FLOORS

Floor Exposure Factor

Select the appropriate factor from the descriptions below:

☐ Building on posts or pillars with no skirts below floor	1.0
☐ Crawl space skirted	0.8
☐ Rock wall basement	0.8
☑ More than two feet of basement wall exposed above grade	0.8
☐ Building on slab	0.5
☐ Building with tight crawl space	0.5
☐ Building with tight basement (heated or unheated)	0.5

'R' Value of Floor

List below all materials in floor deck, including carpet but neglecting floor joists, starting from inside surface and working down.

Insert 'R' value for each component from Table I

Material	Thickness	'R' Value
Interior Surface	---	.68
LINOLEUM		
PLYWOOD	1/2"	
SUB-FLOOR	5/8"	
Interior Surface	---	.68

FILL IN AT JOB SITE

[ ] sq.ft. X [ ] X [ ] ÷ [ ] = [ ]

Floor Area (from Building Description) | Floor Exposure Factor | District Heating Factor | Total 'R' Value | Heating Units Required

Potential Savings on Floor Heat Losses

Floors can sometimes be insulated to reduce heat loss but this is often difficult, and where water pipes are below the floor may cause freezing problems during very cold spells. However, every floor should be protected from drafts, etc., so that it has a floor exposure factor of 0.5. With this exposure factor for this building, the heat loss through the floor would be:

[ ] sq.ft. X [0.5] X [ ] ÷ [ ] = [ ]

Floor Area From Above | Floor Exposure Factor | District Heating Factor | 'R' Value from Above | Potential Heating Units

Subtract the potential heating units from those now required and Enter Here → [ ]

Potential Heating Savings

TYPE OF HEAT LOSS	HEATING UNITS REQUIRED	POTENTIAL HEATING SAVINGS	PROPOSED CHANGES TO STRUCTURE	HEATING UNITS TO BE SAVED
CONDUCTION THRU: FLOORS				

HEAT LOSSES BY CONDUCTION THROUGH CEILINGS

Area of Ceiling

(Take area of upstairs ceiling in a two-story house)

Ceiling area will normally be the same as floor area (from building description sheet)

Material	Thickness	'R' Value
Inside Surface	—	.68
GYPSUM BOARD	3/8"	
FIBERGLASS	2"	
Inside Surface (.68)	---	
OR		
[illegible]	---	

Distance between joists/rafters: 16"

FILL IN AT JOB SITE

[ ] sq.ft. (Ceiling Area) X [ ] (District Heating Factor) ÷ [ ] (Total 'R' Value) = [ ] (Heating Units Required)

Potential Savings by Insulation of Ceilings

A well insulated ceiling (with 6 inches of insulation) should have an 'R' value of 20. If this was so for this building, the ceiling heat loss would be:

[ ] sq.ft. (Ceiling Area) X [ ] (District Heating Factor) ÷ 20 ('R' Value) = [ ] (Potential Heating Units)

Subtract the potential heating units from those now required and Enter Here → [ ] Potential Heating Savings

TYPE OF HEAT LOSS	HEATING UNITS REQUIRED	POTENTIAL HEATING SAVINGS	PROPOSED CHANGES TO STRUCTURE	HEATING UNITS TO BE SAVED
CONDUCTION THRU: CEILINGS				

PAGE 4

CHART 38

HEAT LOSSES BY CONDUCTION THROUGH WALLS

Total Perimeter of Outside Wall ____ ft.

×

Total Height of Outside Wall ____ ft.

=

Gross Wall Area ____ sq.ft.

−

Total Area of all Windows and Doors (from previous two pages) ____ sq.ft.

=

Net Wall Area ____ sq.ft. × ____ ÷ ____ = ____

District Heating Factor | Total 'R' Value | Heating Units Required

'R' Value of Outside Walls

List below all materials in walls, starting from inside and including air spaces within the wall. Insert 'R' value for each component from Table I.

Material	Thickness	'R' Value
Inside surface	---	.68
GYPSUM BOARD	3/8"	
AIR SPACE	3/4"	
FIBERGLASS	2"	
AIR SPACE	3/4"	
SHEATHING	5/8"	
ASBESTOS SHINGLES	1/4"	
Outside surface	---	.17

FILL IN AT JOB SITE

Potential Savings by Insulation

Well insulated walls should have an 'R' value of 15. If this was so for this building, the wall heat loss would be:

____ × ____ ÷ 15 = ____

Net Wall Area (from box above) | District Heating Factor | 'R' Value | Potential Heating Units

Subtract the potential heating units from those now required and Enter Here..... ____

Potential Heating Savings

TYPE OF HEAT LOSS	HEATING UNITS REQUIRED	POTENTIAL HEATING SAVINGS	PROPOSED CHANGES TO STRUCTURE	HEATING UNITS TO BE SAVED
CONDUCTION THRU: WALLS				

CHART 39

JOB SHEET A

THIS PAGE IS REMOVABLE FOR USE AT JOB SITE

Name _____

Address _____

Type of Materials	Quantity Required	Estimated Cost	Location Where Materials Are To Be Installed (Walls, Ceiling, etc.)	Installation Diagram No.	Special Instructions
	(INSERT CARBON PAPER UNDER TABLE AT TOP OF PAGE ONLY)				

Map or directions for locating home:

ROUTE 222 FROM CENTER OF TOWN 1.5 MILES, FIRST HOUSE ON LEFT AFTER CROSSING BRIDGE.

FILL IN AT JOB SITE

WORK RECORD

Activity	Date	Supervisor	Comments
Order Materials			
Install Materials			

4-STEP PROCESS

1. INSPECTION
   OF THE BUILDING
2. CALCULATION
   OF HEAT LOSSES

CHART 41

(2) On pages 2 thru 7, calculate the heat loss by Infiltration and by Conduction thru the separate parts of the building, and enter the results in the table at the bottom of each page, and in the Summary Table on page 8.

HEAT LOSS BY INFILTRATION

Volume of Air in building

Floor Area ☐ sq.ft. X

Height to ceiling (to upstairs ceiling in two-story house) ☐ ft. =

HOUSE DRAFT INDEX: Opposite each of the four component parts of a building in the table below, place a check mark in the circle adjacent to the features which best describe the condition of the building.

BUILDING COMPONENT	ONE Air Change Per Hour ①	TWO Air Change Per Hour ②	THREE Air Change Per Hour ③
CELLAR or CRAWL SPACE	Tight, no cracks, caulked sills, sealed cellar windows, no grade entrance leaks ○ / Plywood floor, no trap door leaks, no leaks around water, sewer and electrical openings	Some foundation cracks, no weather stripping on cellar windows, grade entrance not tight ✓ / Tongue and groove board floor, reasonable fit on trap doors, around pipes, etc.	Stone foundation, considerable leakage area, poor seal around grade entrance ○ / Board floor, loose fit around pipes, etc.
WINDOWS	Storm windows with good fit ✓ (some)	No storm windows, good fit on regular windows ○	No storm windows, loose fit on regular windows ○
DOORS	Good fit on storm doors ○	Loose storm doors, poor fit on inside door ✓	No storm doors loose fit on inside door ○
WALLS	Caulked windows and doors, building paper used under siding ○	Caulking in poor repair, building needs paint ✓	No indication of building paper, evident cracks around door and window frame ○

FILL IN AT JOB SITE

MULTIPLY the number of check marks in the first column by 1, the second column by 2, and the third column by 3. The Draft Index will be the sum of these products, divided by 4.

☐ cu.ft. (Volume) X ☐ (Draft Index) X ☐ (District Heating Factor) X .02 = ☐ (Heating Units Now Required)

Potential Savings by Reducing Infiltration

It should be possible to reduce the draft index for a building to 1 (that is reduce the number of air changes to one per hour). If the draft index for this building was improved to 1, the infiltration loss would be:

☐ cu.ft. (Volume (from above)) X 1 (Draft Index) X ☐ (District Heating Factor) X .02 = ☐ (Potential Heating Units)

Subtract the potential heating units from those now required and enter here → ☐

TYPE OF HEAT LOSS	HEATING UNITS REQUIRED	POTENTIAL HEATING SAVINGS	PROPOSED CHANGES TO STRUCTURE	HEATING UNITS TO BE SAVED
INFILTRATION				

HEAT LOSSES BY CONDUCTION THROUGH FLOORS

Floor Exposure Factor

Select the appropriate factor from the descriptions below:

☐ Building on posts or pillars with no skirts below floor	1.0
☐ Crawl space skirted	0.8
☐ Rock wall basement	0.8
☑ More than two feet of basement wall exposed above grade	0.8
☐ Building on slab	0.5
☐ Building with tight crawl space	0.5
☐ Building with tight basement (heated or unheated)	0.5

'R' Value of Floor

List below all materials in floor deck, including carpet but neglecting floor joists, starting from inside surface and working down.

Insert 'R' value for each component from Table I

Material	Thickness	'R' Value
Interior Surface	---	.68
LINOLEUM		
PLYWOOD	1/2"	
SUB-FLOOR	5/8"	
Interior Surface	---	.68

FILL IN AT JOB SITE

[ ] sq.ft. X [ ] X [ ] ÷ [ ] = [ ]

Floor Area (from Building Description) | Floor Exposure Factor | District Heating Factor | Total 'R' Value | Heating Units Required

Potential Savings on Floor Heat Losses

Floors can sometimes be insulated to reduce heat loss but this is often difficult, and where water pipes are below the floor may cause freezing problems during very cold spells. However, every floor should be protected from drafts, etc., so that it has a floor exposure factor of 0.5. With this exposure factor for this building, the heat loss through the floor would be:

[ ] sq.ft. X [0.5] X [ ] ÷ [ ] = [ ]

Floor Area From Above | Floor Exposure Factor | District Heating Factor | 'R' Value from Above | Potential Heating Units

Subtract the potential heating units from those now required and Enter Here → [ ]

Potential Heating Savings

TYPE OF HEAT LOSS	HEATING UNITS REQUIRED	POTENTIAL HEATING SAVINGS	PROPOSED CHANGES TO STRUCTURE	HEATING UNITS TO BE SAVED
CONDUCTION THRU: FLOORS				

HEAT LOSSES BY CONDUCTION THROUGH CEILINGS

Area of Ceiling

(Take area of upstairs ceiling in a two-story house)

Ceiling area will normally be the same as floor area (from building description sheet)

Material	Thickness	'R' Value
Inside Surface	---	.68
GYPSUM BOARD	3/8"	
FIBERGLASS	2"	
Inside Surface (.68) OR	---	
[illegible]	---	

Distance between joists/rafters: 16"

FILL IN AT JOB SITE

[ ] sq.ft. (Ceiling Area) X [ ] (District Heating Factor) ÷ [ ] (Total 'R' Value) = [ ] (Heating Units Required)

Potential Savings by Insulation of Ceilings

A well insulated ceiling (with 6 inches of insulation) should have an 'R' value of 20. If this was so for this building, the ceiling heat loss would be:

[ ] sq.ft. (Ceiling Area) X [ ] (District Heating Factor) ÷ 20 ('R' Value) = [ ] (Potential Heating Units)

Subtract the potential heating units from those now required and Enter Here → [ ] Potential Heating Savings

TYPE OF HEAT LOSS	HEATING UNITS REQUIRED	POTENTIAL HEATING SAVINGS	PROPOSED CHANGES TO STRUCTURE	HEATING UNITS TO BE SAVED
CONDUCTION THRU: CEILINGS				

PAGE 4

HEAT LOSSES BY CONDUCTION THROUGH SINGLE GLASS WINDOWS
(Assuming R = 1 for single glass)

Area of Single Glass Windows:

If none, enter 0 and go to next sheet on double windows and doors

Width	x Height	x Number	= Area

TOTAL [ ] sq.ft. X [ ] District Heating Factor = [ ] Heating Units Required

Potential Saving by Double Glazing

Double glazing or adding storm windows will cut the heat loss by half, so divide heating units by two, and Enter Here → [ ] Potential Heating Savings

TYPE OF HEAT LOSS	HEATING UNITS REQUIRED	POTENTIAL HEATING SAVINGS	PROPOSED CHANGES TO STRUCTURE	HEATING UNITS TO BE SAVED
CONDUCTION THRU: SINGLE-GLASS WINDOWS				

PAGE 5

HEAT LOSSES BY CONDUCTION THROUGH DOUBLE GLASS OR
PLASTIC COVERED WINDOWS AND THROUGH DOORS
(Assuming R = 2 for these units)

Area of Double Glass and Doors

Width	x Height	x Number	= Area

TOTAL [ ] sq.ft X [ ] ÷ [2] = [ ]

District Heating Factor — 'R' Value — Heating Units Required

Potential Savings

Triple glazing of windows can be done but is not usually practical. If no change is made in the windows, the Potential Saving will be 0 heating units and should be entered here → [ ] Potential Heating Savings

(If windows are triple glazed, the "R" value will be approx. 3 and the Potential Savings will be one-third of the "Heating Units Required.")

TYPE OF HEAT LOSS	HEATING UNITS REQUIRED	POTENTIAL HEATING SAVINGS	PROPOSED CHANGES TO STRUCTURE	HEATING UNITS TO BE SAVED
CONDUCTION THRU: DOORS & DOUBLE-GLASS WINDOWS				

PAGE 6

CHART 46

HEAT LOSSES BY CONDUCTION THROUGH WALLS

Total Perimeter of Outside Wall ____ ft.

×

Total Height of Outside Wall ____ ft.

=

Gross Wall Area ____ sq.ft.

−

Total Area of all Windows and Doors (from previous two pages) ____ sq.ft.

=

Net Wall Area ____ sq.ft. × ____ ÷ ____ = ____

District Heating Factor | Total 'R' Value | Heating Units Required

'R' Value of Outside Walls

List below all materials in walls, starting from inside and including air spaces within the wall. Insert 'R' value for each component from Table I.

Material	Thickness	'R' Value
Inside surface	---	.68
GYPSUM BOARD	3/8"	
AIR SPACE	3/4"	
FIBERGLASS	2"	
AIR SPACE	3/4"	
SHEATHING	5/8"	
ASBESTOS SHINGLES	1/4"	
Outside surface	---	.17

FILL IN AT JOB SITE

Potential Savings by Insulation

Well insulated walls should have an 'R' value of 15. If this was so for this building, the wall heat loss would be:

____ × ____ ÷ 15 = ____

Net Wall Area (from box above) | District Heating Factor | 'R' Value | Potential Heating Units

Subtract the potential heating units from those now required and Enter Here..... ____

Potential Heating Savings

TYPE OF HEAT LOSS	HEATING UNITS REQUIRED	POTENTIAL HEATING SAVINGS	PROPOSED CHANGES TO STRUCTURE	HEATING UNITS TO BE SAVED
CONDUCTION THRU: WALLS				

4-STEP PROCESS

1. INSPECTION
   OF THE BUILDING
2. CALCULATION
   OF HEAT LOSSES
3. EVALUATION
   OF THE DATA

CHART 48

③ Use the instructions on page 11 of the FEA Winterization Manual to assess which potential savings can be obtained most successfully.

④ Fill out the following Summary Table by entering the "Heating Units Required" and the "Potential Heating Savings" from the corresponding tables at the bottom of pages 2 through 7. Then, write in the "Proposed Changes" and "Heating Units to be Saved" by such changes.

HEAT REQUIREMENT ESTIMATES (Annual Heating Units Needed)

TYPE OF HEAT LOSS		HEATING UNITS REQUIRED	POTENTIAL HEATING SAVINGS	PROPOSED CHANGES TO STRUCTURE	HEATING UNITS TO BE SAVED
INFILTRATION	From Page 2				
CONDUCTION THRU: FLOORS	Page 3				
CONDUCTION THRU: CEILINGS	Page 4				
CONDUCTION THRU: SINGLE-GLASS WINDOWS	Page 5				
CONDUCTION THRU: DOORS & DOUBLE-GLASS WINDOWS	Page 6				
CONDUCTION THRU: WALLS	Page 7				
TOTALS					

⑤ Use the space below to calculate the quantities and cost of materials needed to make the proposed changes to the building.

⑥ Fill in job sheet on opposite page.

JOB SHEET A

THIS PAGE IS REMOVABLE FOR USE AT JOB SITE

Name_____

Address_____

Type of Materials	Quantity Required	Estimated Cost	Location Where Materials Are To Be Installed (Walls, Ceiling, etc.)	Installation Diagram No.	Special Instructions

(INSERT CARBON PAPER UNDER TABLE AT TOP OF PAGE ONLY)

Map or directions for locating home:

ROUTE 222 FROM CENTER OF TOWN 1.5 MILES, FIRST HOUSE ON LEFT AFTER CROSSING BRIDGE.

FILL IN AT JOB SITE

WORK RECORD

Activity	Date	Supervisor	Comments
Order Materials			
Install Materials			

JOB SHEET B

THIS PAGE IS RETAINED WITH JOB BOOK AS PERMANENT RECORD

Type of Materials	Quantity Required	Estimated Cost	Location Where Materials Are To Be Installed (Walls, Ceiling, Etc.)	Installation Diagram No.	Special Instructions

Total Cost

⑦ PAY-OFF TIME

This is the number of seasons for fuel savings to pay off the cost of winterization.

Total Cost (from job sheet above) = "Pay-off" Time (seasons)

Fuel Factor
Fuel Oil = 1
Natural Gas = 120
Electricity = 30

X

Total Heating Units Saved (From page 8)

X

Price of Fuel Per gal, cu.ft., KWH

4-STEP PROCESS

1. INSPECTION
   OF THE BUILDING
2. CALCULATION
   OF HEAT LOSSES
3. EVALUATION
   OF THE DATA
4. INSTALLATION
   OF THE MATERIALS

CHART 52

TYPICAL COST OF MATERIALS					
Material	Type	Unit Size	Unit Cost	Local Vendor	Date
Mineral Wool	16" Batt	8 ft.			
" "	Loose	Cu. ft.			
Storm Window	Glass				
"	Plastic film				
Weatherstrip					
Caulking					
Strapping					
Heating Oil		Gal			
Electricity		KWH			
Natural Gas		Cu. ft.			
Bottled Gas					
Kerosene		Gal			
Coal/Coke		Ton			
Wood		Cord			

CHART 53

Home Winterization Manual

Federal Energy Administration

114

JUNE 1975

This HOME WINTERIZATION MANUAL

was developed for the

Federal Energy Administration

by

Richard Hill, Professor Mechanical Engineering, University of Maine
Charles W. Kittridge, Extension Agricultural Engineer, University of Maine
Norman Smith, Professor Agricultural Engineering, University of Maine

It is intended for use in inspecting and evaluating homes to determine if winterization measures are needed and gives directions for applying winterization materials.

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BEING COMFORTABLE IN WINTER MEANS KEEPING WARM AT MINIMUM COST

This takes heat, which comes from fuel, which costs a whole lot more than it once did.

MOST HOMES CAN USE MUCH LESS FUEL WITHOUT SACRIFICING COMFORT

This manual explains the how and why of winter comfort heating. It provides an easy method of approximating how much heat will be needed to keep any particular building warm and explains how to assess the benefits of improvements made to the building, such as adding storm windows, insulating ceilings, excluding drafts, etc.

Most such improvements cost money. Usually they save more than they cost. In the next few pages we shall see how to make heating improvements and how to figure the heat saved.

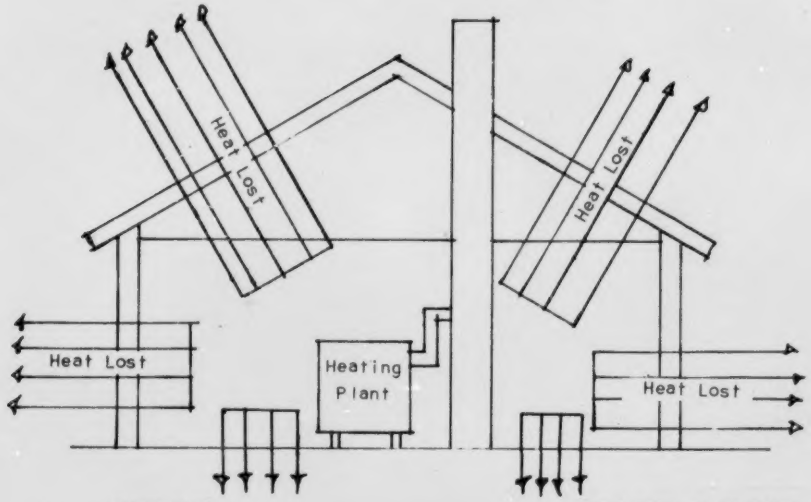
One basic premise that we must get straight--

IT IS NOT "COLD" THAT COMES IN-- IT IS THE HEAT WE BUY THAT ESCAPES TO THE OUTSIDE

Heat always tends to flow from wherever the temperature is higher to wherever the temperature is lower. For example--put a pan of cold water on a hot stove and heat flows from the stove through the bottom of the pan into the water, heating it up to a higher temperature. Pan bottoms are, therefore, made of materials which CONDUCT heat easily. To keep the pan from losing heat after it comes off the stove we can stand it on an asbestos pad--a material which RESISTS passage of heat, or in other words, provides INSULATION.

In just the same way as heat escapes from a pan of hot water, heat will pass out of a heated building to the cold outside surroundings. If we want to keep the building at a comfortable temperature, we must release heat into it at the same rate at which heat escapes out of the structure. Heating buildings is really as simple as that.

Take the building below--



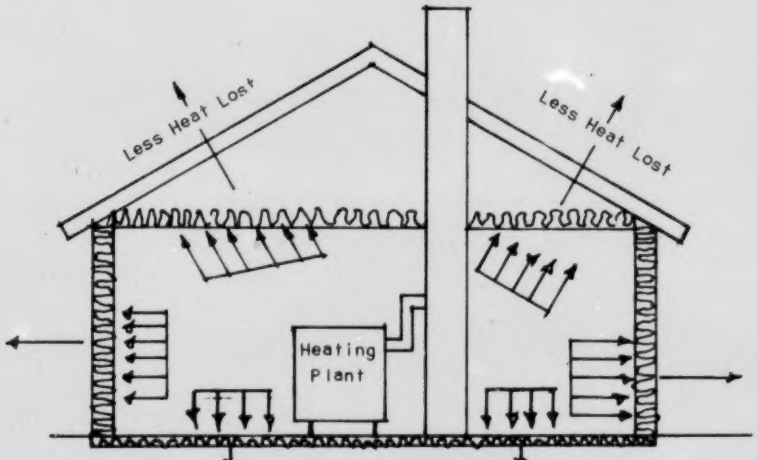
IF

HEAT GIVEN OFF BY THE HEATING PLANT = HEAT LOSS FROM THE BUILDING

THEN

TEMPERATURE INSIDE STAYS UP

Make it more difficult for heat to escape from a building by insulating, double glazing or sealing cracks and less heat will be needed to maintain comfortable temperatures inside the building. And less heat required means less fuel used, which means money saved.



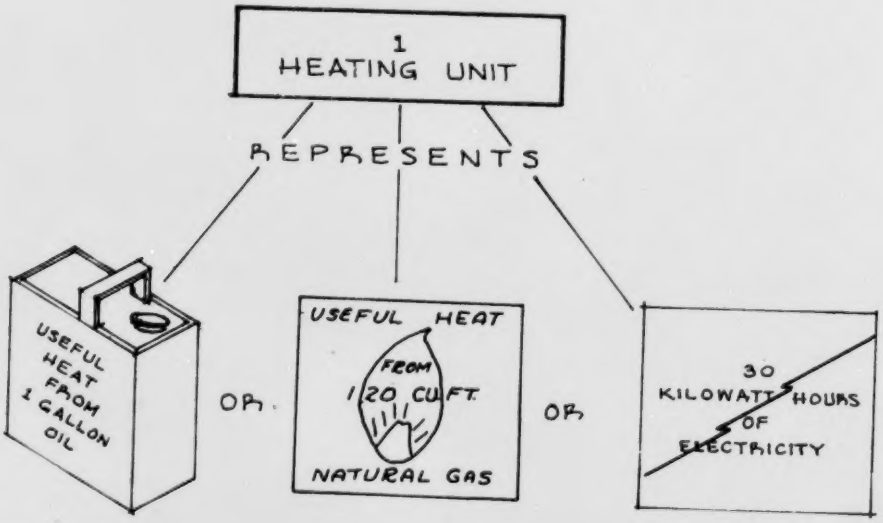
LESS HEAT ESCAPING MEANS LESS HEAT AND LESS FUEL NEEDED TO STAY COMFORTABLE INSIDE

Heat escapes from a building in two ways, by CONDUCTION and by INFILTRATION.

In the next few pages, these processes will be explained--but first some definitions to make everything clear.

We must have a unit to measure heat losses. Normally we use the British Thermal Unit--BTU. This is the amount of heat it takes to raise the temperature of one pound of water by 1 °Fahrenheit. Another way of "sizing" a BTU is to say it is about the amount of heat given off when a wooden match is burned completely. All fuel values or heat requirements can be expressed in BTU s. For example, using one kilowatt hour of electricity releases 3412 BTU s, one pound of wood burned completely will give off about 8000 BTU s, etc.

Working with BTU s means doing calculations with large numbers in which it is easy to make errors. This manual uses the concept of Heating Units to simply the figuring--



Obviously, the Heating Unit is an approximation, because not all oil or gas heating plants operate at the same efficiency. However, the Heating Unit is a fairly accurate estimate of what a normal oil or gas furnace should get out of the quantities of those fuels illustrated above. The Heating Unit does, in fact, represent about 100,000 BTU s.

In this manual, we calculate heating requirements on a seasonal basis. Therefore, if a building is calculated to require 1200 Heating Units, that figure will represent the approximate number of gallons of oil it should use per year, if it has an efficient furnace. If the actual fuel use is known and is very different from the calculated figure, a further check needs to be made to find the reason. It may be due to calculation errors, wrong measurements in the building, or the furnace may not be functioning correctly. It may be that the building has only been partially heated previously, with much of the living space not used in the winter. Working with Heating Units in this way can enable us to spot errors or circumstances we might otherwise miss. Incidentally, if the furnace which provides heat for the building also provides domestic hot water, this will increase the fuel usage approximately 20%.

To allow for climatic differences between areas, heating engineers use Degree Day figures, one degree day representing a 24 hour period in which the average outside temperature is 1° F below a base temperature of 65 °F. Many northern areas will have over 7000 degree days in a heating season--once again a large number. This manual uses the District Heating Factor which, for an area with 4000 heating degree days, will be 1, for 6000 degree days 1.5, and so on. The map on page 8 shows the District Heating Factors for various areas. Simply look up the appropriate factor for your area and use it in figuring all heat losses for any house in your district.

Home winterization requires four steps to determine what should be done, where and how:

1. INSPECTION of the building to determine construction.
2. CALCULATION of heat losses from the building.
3. EVALUATION of the building and heat losses to determine what winterization measures should be made.
4. INSTALLATION of the winterization materials.

A Job Book is used for recording the information on each building. It also shows the procedure for calculating and summarizing heat loss and serves as an order form for listing and procuring materials.

BUILDING HEAT LOSS BY CONDUCTION

Heat is lost from the home through the exterior surface of the building by heat flowing by conduction through the building materials. The rate of heat loss from the warm side to the cold side through the exterior surface depends upon the size of the surface, the length of time the heat flow occurs, the temperature difference between the two sides of the exposed area, and the construction of the section, that is the type of material used in the construction. All materials used in building construction reduce the flow of heat. Some materials are much better than others at reducing heat flow. The more effective materials are used as insulation.

Insulation

Three general types of insulating materials are commonly used in building construction. They are loose fill, blanket or batt, and rigid insulation.

Loose fill types of insulation include glass, rockwool, cellulose fibers, wood fibers, and others. Fill type insulating materials are best utilized on horizontal surfaces, such as ceiling areas. This type of insulation used in vertical areas tends to settle, and unless provision is made to refill the space, cold spots can occur.

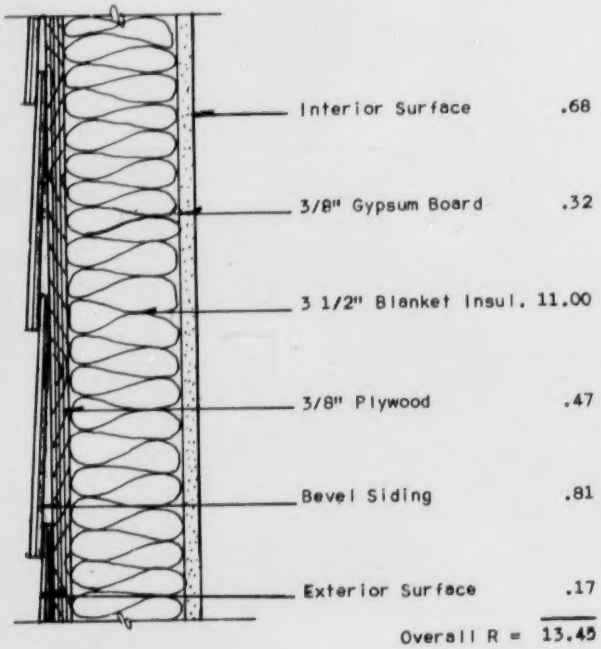
Blanket, or batt insulation, is commonly made of glass or rockwool, or wood fiber. They are usually enclosed in a paper envelope or fastened to a backing of kraft paper or aluminum foil. Some blanket types of insulation have no backing and are intended to be used when no vapor barrier is required. Blanket insulation comes in rolls of various lengths and thicknesses. Batt insulation is usually thicker and comes in shorter lengths. Both blanket and batt insulation are available for framing spacing of 16 and 24 inches. Other widths are available on special order.

Rigid insulation, in addition to providing insulating value, also provides structural strength. Rigid insulation is available in board form, such as various fiberboard materials, and foamed plastics. This type of insulation is more expensive and is usually not used for home winterization.

Table 1 lists the insulating value of most of the common material found in house construction. The 'R' value shown in the righthand column indicates the effectiveness, or resistance value of the material. The higher the resistance value, the better its insulating quality. When building sections are made up of several materials, the resistance value of each of the individual materials can be added together to obtain the overall total resistance value. Once you know the overall 'R' value you can use it in the calculation outlined in the Job Book to determine heat loss. Thicknesses of 3 1/2 inches (R-11) and 6 inches (R-19) are most common.

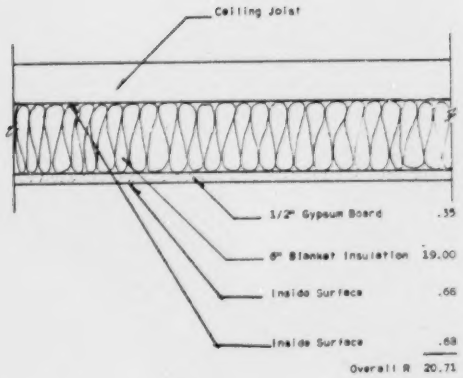
Exterior Walls

To determine the insulating value of an exterior wall section, it is necessary to know the construction of the wall. Using Table I, determine the 'R' value for each material making up the wall. Add together these values to obtain the overall 'R' value of the wall.

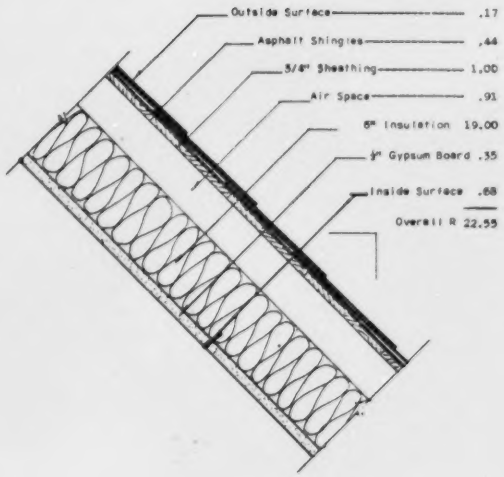


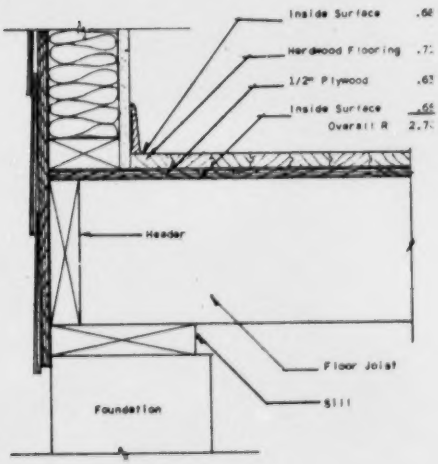
Ceilings and Roofs

The insulating value of roof and ceiling sections can be determined by adding the 'R' value of each of the materials making up the section. It is necessary to know the construction of the ceiling or roof section. Add together the 'R' values of the materials making up the section from the values given in Table 1 to obtain the overall 'R' value of the section. For ceilings with attic space over the insulation, use an interior surface resistance for the surface next to the attic due to the fact that still air conditions exist on the outside of the insulation. The illustration at the right shows the procedure for determing the overall resistance value for ceiling sections.



For roof sections, the procedure determining overall resistance value are similar to the wall section. First, determine the construction of the roof section and then add the resistances of the individual materials making up the roof section to obtain the overall 'R' value for the roof. The diagram at the right shows the procedure for determining the overall 'R' value for roof areas.





Floors

To determine the insulating value of floors, add the 'R' value of the individual materials making up the floor section together to determine the overall 'R' value. Use the interior surface resistance for the surface next to the basement or crawl space area. The heat loss from floors depends upon the temperature below the floor. Basement and crawl space temperatures depend upon the quality of construction. In calculating floor heat loss in this manual a floor exposure factor is used to estimate changes in floor heat loss due to different types of foundation construction.

Vapor Barriers

In the winter, moisture moves from the inside of the home to the outside through the exterior surfaces. Vapor barriers are installed to reduce the flow of moisture through the insulation so that condensation will not occur. Blanket or batt insulation usually has vapor barriers attached. Polyethylene film (4 mil) can be used as a separate vapor barrier if needed. Vapor barriers should always be installed on the warm side (inside) to stop the moisture before it reaches the insulation. If possible, vent the cold side of the insulation to the outside to remove moisture which escapes through the insulation. When blanket or batt insulation with an attached vapor barrier is used, kraft paper backing is usally cheaper and just as effective as foil backing.

TABLE I. INSULATION VALUE OF COMMON MATERIALS

Source: ASHRAE Guide and Data Book

MATERIAL	THICKNESS	'R' VALUE
Air Film and Spaces		
Air space, bounded by ordinary materials	3/4" or more	0.91
Air Space, bounded by aluminum foil	3/4" or more	2.17
Exterior surface resistance	- -	0.17
Interior surface resistance	- -	0.68
Masonry		
Sand and gravel concrete block	8"	1.11
Sand and gravel concrete block	12"	1.28
Lightweight concrete block	8"	2.00
Lightweight concrete block	12"	2.13
Face brick	4"	0.44
Concrete cast in place	8"	0.64
Building Materials - General		
Wood sheathing or subfloor	3/4"	1.00
Fiber board insulating sheathing	3/4"	2.10
Plywood	5/8"	0.79
Plywood	1/2"	0.63
Plywood	3/8"	0.47
Bevel lapped siding	1/2" x 8"	0.81
Bevel lapped siding	3/4" x 10"	1.05
Vertical tongue and groove board	3/4"	1.00
Drop siding	3/4"	0.94
Asbestos board	1/4"	0.13
3/8" gypsum lath and 3/8" plaster	3/4"	0.42
Gypsum board	3/8"	0.32
Interior plywood panel	1/4"	0.31
Building paper	--	0.06
Vapor barrier	--	0.00
Wood shingles	--	0.87
Asphalt shingles	--	0.44
Linoleum	--	0.08
Carpet with fiber pad	--	2.08
Hardwood floor	--	0.71
Insulation Materials (mineral wool, glass wool, wood wool, etc.)		
Blanket or batts	1"	3.70
Blanket or batts	3 1/2"	11.00
Blanket or batts	6"	19.00
Loose fill	1"	3.33
Rigid insulation board (sheathing)	3/4"	2.10
Windows and Doors		
Single window	--	Approx. 1.00
Double window	--	Approx. 2.00
Exterior door	--	Approx. 2.00

BUILDING HEAT LOSS BY INFILTRATION

Any building will constantly exchange air with its environment--outside air leaks in--inside air leaks out. A certain amount of this exchange (say one complete air change per hour) is necessary for ventilation, but most buildings have much more than is needed. In winter, the air that leaks in is cold; the air that leaks out is warm; fuel is consumed to supply this temperature difference.

This leakage or infiltration is caused by wind, the building acting as a chimney, and the opening of outside doors.

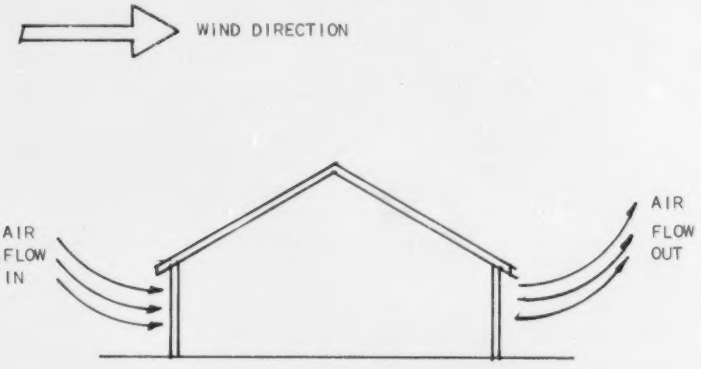


FIG. 1 - INFILTRATION BY WIND

The effect of door openings and wind needs little explanation; but the chimney effect may not be obvious. When air in a building is warmer than the outside air, the entire building acts like a chimney--hot air tends to rise and leak out of cracks at the upper levels and suck cold air in through cracks at the lower levels. Both the temperature difference and building height contribute to this effect. A two story house with a 68°F inside temperature and a 30°F outside temperature will produce a "chimney" leakage equivalent to a ten mile per hour wind blowing against the building.

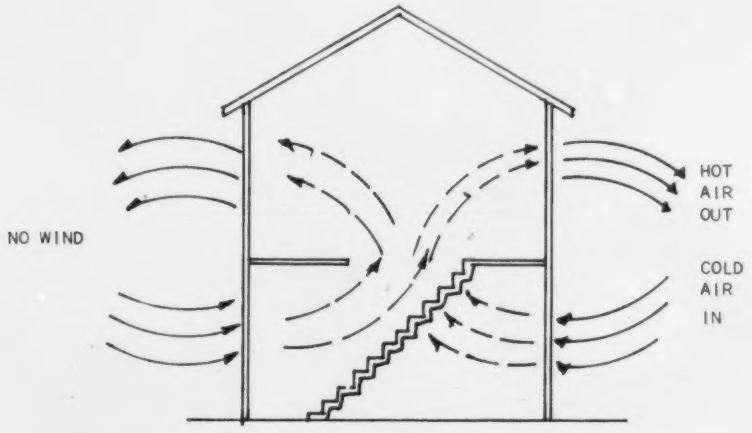


FIG. 2 - "CHIMNEY-EFFECT"

Each cubic foot of air that enters the house requires approximately .02 BTU to raise the temperature 1° F. To determine the heat loss from infiltration, it is necessary that the rate of air movement through the home be known. Most houses vary from one to three air changes per hour, depending on construction. An infiltration check list is provided to determine the approximate infiltration rate.

DISTRICT HEATING FACTOR
NORTHEAST REGION

HOME WINTERIZATION: STEP 1 - INSPECTION OF BUILDING

When you Visit the House

A thorough inspection of the house is necessary in order to secure the details for determining winterization measures. Check the house as thoroughly as possible and make sure that all the details described below are collected before you leave. If you find unusual circumstances in house construction, location, building arrangement, or other features that need to be taken into consideration, make notes on page 1 of the Job Book for future reference.

1. Measure the outside of the house, the length, the width, the height of the sidewalls. Draw a sketch of each side of the house and a floor plan on page 1 of the Job Book. Note the dimensions. It is not necessary that you measure the building to the last inch. If you find that you do not have access to some of the dimensions, estimate as close as possible. You will find that it is accurate enough for your calculations.

2. Check the doors and windows. Sketch them in on page 1 of the Job Book in their proper location, noting their construction, with an (S) for a single window or door and a (D) for a double window or door. If you do not have access to a window, estimate its dimensions. Otherwise, measure and note the sizes in the Job Book.

3. Check the construction of the exterior of the home. Check the construction of the walls, the exterior ceiling, roof and floor surfaces. It is necessary to know what kind of materials make up these areas in order to determine how well they are insulated. If you cannot readily determine this, ask the occupants. If they don't know then you may be able to find out by taking off a switch plate or a plate over an outlet box on the exterior wall to examine the inside of the wall. However, if you have difficulty finding what is in the wall or ceiling, chances are that you can't do anything about it anyway. Once you have found the construction material for the exterior surface, list the construction materials in the Job Book under walls, ceiling and roof, or floors, pages 3, 4, and 7. Note the material and thickness of the material so that you can later determine its insulating value. Note also if you can get access to the area where the insulation will have to be installed. If, for instance, a wall is closed on both sides with sheathing material, it is difficult to add insulation. However, if you have an attic space over a ceiling which is accessible, you can insulate the ceiling.

4. Check the building foundation to determine the floor exposure factor on page 3 of the Job Book. Put a check mark in the box opposite the foundation description which best describes the actual building foundation.

5. Check the condition of the home to determine the approximate infiltration rate. Put a check mark in the box under category 1, 2, or 3 which best describes the condition of each building component in the table page 2 of the Job Book. In order to select the appropriate category, check for the following:

   Building Foundation

   To determine leakage around sills and cellar windows, examine the structure from the inside. Look for "daylight" between the sill and the foundation. Feel for drafts at cellar windows. Push on windows to see if they are loose or rattle. Check for missing putty on sash. This detailed analysis will help decide if the cellar is in category 1, 2, or 3.

   If the building is on posts, infiltration must be evaluated by an examination of the floor. Open kitchen floor cabinets and look at pipe holes for the sink drain, etc. If these are tight, the building is category 1--if very open, category 3. Check the construction of the floor: if made of plywood or subfloor, paper, and finished floor, check category 1. If board floor with visible cracks and discernible drafts, check category 3.

   Doors

   Open the door quickly--A good fit will create a vacuum and resist the effort to open. A loose door will offer very little resistance. An on-hands-and-knees examination of the crack between the door and sill will also help. If a twenty-five cent piece can be pushed under the door, check category 2, if two twenty-five cent pieces can be used, check category 3.

   Windows

   The same evaluation can be used on windows--push hard on the window--if a twenty-five cent piece can be pushed between the window and the casing, check category 2, if two can be used, check category 3.

   Walls

   To determine infiltration through the walls, feel for drafts around outside wall electrical outlets. Check for caulking around doors and windows, condition of paint, check for building paper.

The following are typical features of buildings with infiltration rates of approximately 1, 2, or 3 air changes per hour:

Building Component	One Air Change Per Hour	Two Air Changes Per Hour	Three Air Changes Per Hour
Building with Cellar OR	Tight, no cracks, caulked sills, sealed cellar windows, no grade entrance leaks	Some foundation cracks, no weatherstripping on cellar windows, grade entrance not tight	Stone foundation, considerable leakage area, poor seal around grade entrance
Building with crawl space or on posts	Plywood floor, no trap door leaks, no leaks around water, sewer and electrical openings	Tongue and groove board floor, reasonable fit on trap doors, around pipes, etc.	Board floor, loose fit around pipes, etc.
Windows	Storm windows with good fit	No storm windows, good fit on regular windows	No storm windows, loose fit on regular windows
Doors	Good fit on storm doors	Loose storm doors, poor fit on inside door	No storm doors, loose fit on inside door
Walls	Caulked windows and doors building paper used under siding	Caulking in poor repair, building needs paint	No indication of building paper, evident cracks around door and window frame

Usually building components are not all in the same infiltration category. You can estimate the approximate rate by considering how many of the components are in each category. For example, if two components are in the three air change category and two are in the two air change category, the overall infiltration would be 2 1/2 air changes per hour.

6. Talk with the occupant of the house. Get his comments on the winterization problems and what he thinks can be done about them. Note his comments on page 1 of the Job Book. You may find more problems with the building by talking with the occupant than by looking at the house.

7. If you can, get answers to the questions on page 1A of the Job Book.

8. Before you leave, fill in the directions for locating the house, either by a map or description of how to get there on page 9 of the Job Book. This will help the person who is to do the work on the house.

HOME WINTERIZATION: STEP 2 - CALCULATION OF HEAT LOSSES

The next step in the home winterizing procedure is to calculate the heat losses expected from the house. Only simple calculations are necessary and you can do it away from the job site. By following the Job Book step by step, you can calculate the amount of heat lost in a given season from the building. To do this, you must determine the area of the exposed surface where the heat is lost; determine its insulation (R) value, select the district heating factor from the map on page 8 of the Manual, determine the infiltration rate from the table on page 2 of the Job Book, and from these figures you are able to calculate the heat loss from the building. On each of the pages of the Job Book, calculate the heat loss and the potential heat loss for infiltration losses, losses from windows and doors, floors, ceilings or roof, and walls and summarize these heat losses on page 8 of the center section in the Job Book. If you are unable to determine the construction of the exposed area and its heat loss, note that on the appropriate job sheet and also note it in the summary sheet. You are now ready to determine what winterization measures should be taken on the house.

HOME WINTERIZATION: STEP 3 - EVALUATION OF DATA

Determining Winterization Measures

In order to determine which winterization measures should be undertaken on the home, we need to consider several factors. By following the step-by-step procedure listed below, you should be able to determine the logical areas where winterization should be undertaken.

1. Check the heat units now required on the first column of the Summary Sheet, page 8 of the Job Book. Look for areas that have the highest heat requirement as logical areas for winterization.

2. Check the owner's comments on the bottom of page 1 of the Job Book. The following table may be helpful in determining what winterization measures are indicated from these comments.

Problem	Probable Cause	Remedy
Low house temperature High fuel usage	High heat loss	Add insulation Add storm doors and windows Caulk and weatherstrip doors & windows
Cold floors	Cold crawl space or basement	Add banking to increase crawl space or basement temperature
Drafty house	Loose doors and windows	Add storm doors and windows and caulk around windows and doors
Wet windows	Cold window surface or high humidity	Add storm windows or ventilate to reduce humidity
Wet walls or ceiling (uncommon complaint)	Cold inside surface or high humidity	Insulate wet surface or ventilate to reduce humidity

3. All windows should be fitted with storm windows. Since this measure increases the insulation value of the window, as well as reducing the infiltration through windows, it usually results in the greatest benefit. Storm doors do not give as much benefit as storm windows. Weatherstripping exterior doors is nearly as effective as storm doors and not as expensive.

4. Check to see if insulation can be applied. If there is not at least 6 inches of insulation in the ceiling 3 1/2 inches in the sidewall, and 3 1/2 inches under the floor, if the basement or crawl space is unheated, consider adding insulation. It usually will result in a substantial heat saving. Check the Job Book to determine if insulation can be added to the areas where it is needed. It is usually easy to add insulation to an attic space and difficult to add insulation to a sheathed wall or below the floor.

5. Check to see if the floor exposure factor on page 3 of the Job Book, and infiltration from the foundation, page 2 of the Job Book, can be improved by adding banking materials. The procedure for adding banking materials is shown on page 14 of the Winterization Manual. If floor is over unheated area, consider insulating the floor. If over a crawl space, consider insulating the exposed foundation wall.

6. Check to see if weatherstripping can be installed around single doors and windows, or storm doors, to reduce the infiltration rate. Usually weatherstripping is not necessary if storm windows have been applied. This measure usually is not as effective in reducing heat loss as those listed above, but if for any reason you can't install storm doors and windows, make sure the weatherstripping is adequate.
7. Check to see if the infiltration through the wall can be reduced by caulking around doors and window frames. This is one of the less effective measures of reducing heat loss, however, it may help in a loosely constructed building.

8. You now should be able to determine where the most logical areas of winterization should occur. Fill in the proposed changes in the third column of the Summary Sheet on page 8 of the Job Book and calculate the heat savings from the proposed changes, using the procedure which was originally used in determining the heat requirements.

9. Check the availability and price of winterization materials in your area. Visit several of the building supply dealers and determine what kind of winterization materials are available and the price. It is a good idea to make a list of these as you visit the dealer and from these you will be able to select which dealer has the proper materials available at the most attractive price.

10. Calculate the quantities of materials needed to complete the home winterization under item Number 5, page 8 of the Job Book.

11. Complete the job sheet on page 9 of the Job Book, listing the materials required and their cost, along with the instructions for applying the materials. This sheet is to go to the job site when the work is to be done and any instructions required for the installation of the materials should be made on this sheet.

12. Calculate the total cost of the winterization materials on page 10 of the Job Book, and calculate the pay-off time for winterization materials.

Pages 13 through 22 of the manual show examples of using the Job Book. Follow these pages carefully until you become familiar with the procedure.

EXAMPLE OF COMPLETED JOB BOOK

Before proceeding to Step 4: Installation, the example of the completed Job Book (starting on the facing page) should be carefully reviewed until you are familiar with the procedure.

Instructions for completing the Job Book are given on each page of the Job Book. Explanation of the procedure to be followed will be found in this Manual on pages 9-12.

Federal Energy Administration

Washington D.C. 20461

PROJECT RETRO-TECH

Home Winterization Job Book for

Name: MARY PERKINS

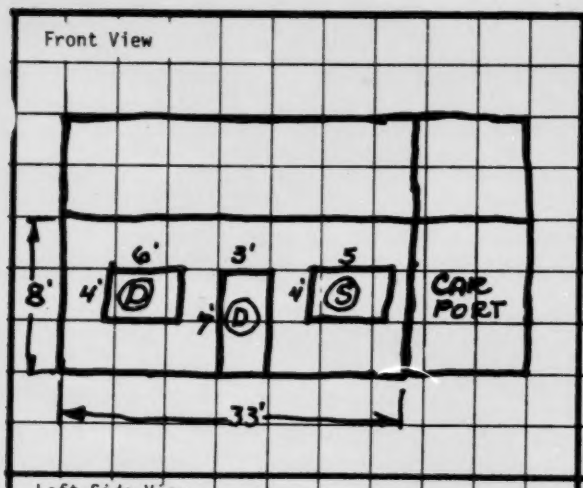
Address: 3 PINE STREET
BANGOR, MAINE

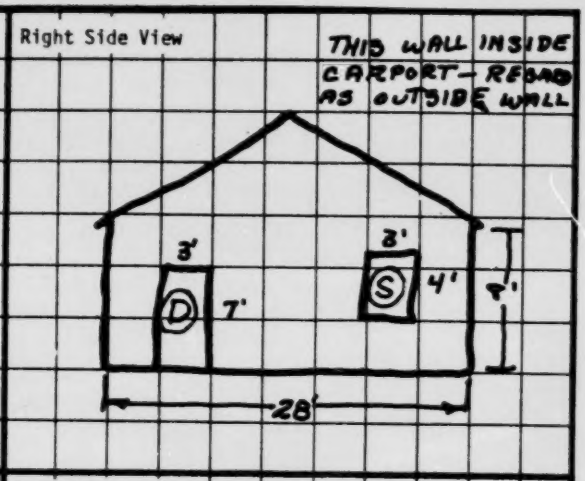
WORK RECORD

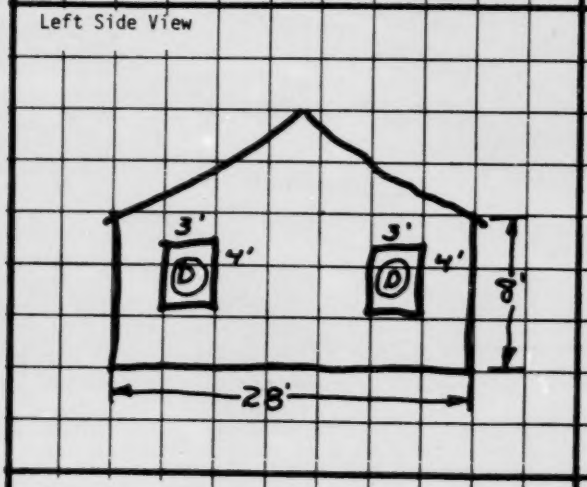
Assignment	Supervisor	Date Completed
HOME EVALUATION:		
Field Inspection (pg. 1-7)	ED JONES	5-2-75
Heat Loss Calculation (pg. 8)	P. SMITH	5-6-75
JOB SHEET (pg. 9-10):		
Order Materials	E. HALL	5-10-75
Install Materials	S. PAUL	6-1-75

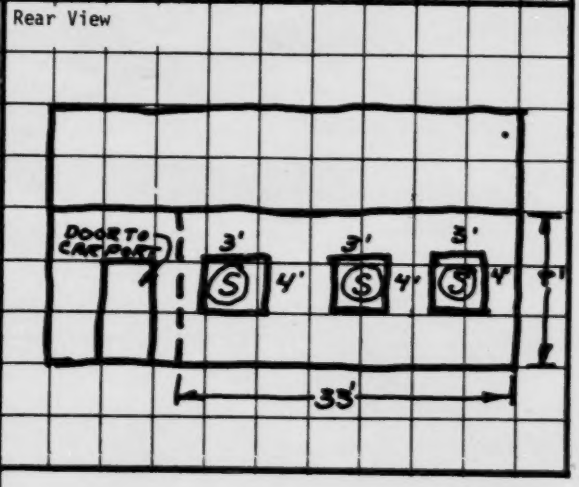
DESCRIPTION OF BUILDING

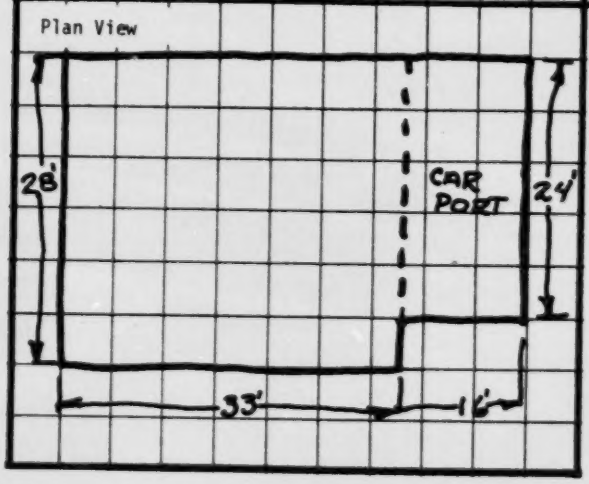
1 Sketch all views and put dimensions on each part shown, e.g., length of walls, width and length of windows, etc. Label all single glass windows (S) and double glass and doors (D). Complete all items in the Job Book labeled "Fill in at Job Site."











Calculation of Floor Area

33 ft.	X	28 ft.	=	924 sq.ft.
Building Length		Building Width		Floor Area

FILL IN AT JOB SITE

DESCRIPTION OF BUILDING
(Continued from Opposite Page)

DWELLING UNIT INFORMATION

* NAME OF HEAD OF HOUSEHOLD
  MARY PERKINS

* NAME & ADDRESS OF OWNER:
  (if not the same as above)
  MARY PERKINS
  3 PINE STREET
  BANGOR, MAINE

* OCCUPANTS OF STRUCTURE:
  Total Number — 5

* STYLE OF STRUCTURE:
  - [✓] One Story
  - [ ] Split-level
  - [ ] Two Story
  - [ ] Other (Specify) _____
  - [ ] 2 1/2 Story

* AGE OF STRUCTURE (Approx): 10 years

* ROOMS IN LIVING SPACE:
  Total Number of Rooms..... 6
  Number Used in Winter..... 6

* OCCUPANTS COMMENTS (e.g., drafty, cold floors, too expensive to heat, etc.):
  FUEL BILLS TOO HIGH
  DRAFTY WINDOWS

HEATING SYSTEM INFORMATION

* TYPE OF FUEL: (P = Primary) (S = Secondary)
  - [P] Fuel Oil
  - [ ] Natural Gas
  - [ ] Bottled Gas
  - [S] Wood
  - [ ] Coal/Coke
  - [ ] Kerosene
  - [ ] Electricity
  - [ ] Other (Specify) _____

* TYPE OF HEATING SYSTEM: (P = Primary) (S = Secondary)
  - [P] Steam/Hot water/Hot Air
  - [S] Fireplace/Stove/Portable Heater
  - [ ] Electrical Baseboard
  - [ ] Other (Specify) _____

* DOMESTIC HOT WATER:
  Does central heating system provide heat for domestic hot water? NO

* THERMOSTAT SETTING IN WINTER (average):
  Day 65° Night 60° None [ ]

* AMOUNT OF FUEL USED LAST HEATING SEASON:

	Primary	Supplementary
Type	FUEL OIL	WOOD
Quantity	1500GAL.	1 CORD
Total Cost	$585.00	$ 45.00

* DISTRICT HEATING FACTOR..... 2
  (from Manual, page 8)

(2) On pages 2 thru 7, calculate the heat loss by Infiltration and by Conduction thru the separate parts of the building, and enter the results in the table at the bottom of each page, and in the Summary Table on page 8.

HEAT LOSS BY INFILTRATION

Volume of Air in building

Floor Area

924 sq.ft.

X

8 ft.

Height to ceiling (to upstairs ceiling in two-story house)

=

HOUSE DRAFT INDEX: Opposite each of the four component parts of a building in the table below, place a check mark in the circle adjacent to the features which best describe the condition of the building.

BUILDING COMPONENT	ONE Air Change Per Hour (1)	TWO Air Change Per Hour (2)	THREE Air Change Per Hour (3)
CELLAR or CRAWL SPACE	Tight, no cracks, caulked sills, sealed cellar windows, no grade entrance leaks ○ Plywood floor, no trap door leaks, no leaks around water, sewer and electrical openings	Some foundation cracks, no weather stripping on cellar windows, grade entrance not tight ✓ Tongue and groove board floor, reasonable fit on trap doors, around pipes, etc.	Stone foundation, considerable leakage area, poor seal around grade entrance ○ Board floor, loose fit around pipes, etc.
WINDOWS	Storm windows SOME ✓ with good fit	No storm windows, good fit on regular windows ○	No storm windows, loose fit on regular windows ○
DOORS	Good fit on storm doors ○	Loose storm doors, poor fit on inside door ✓	No storm doors loose fit on inside door ○
WALLS	Caulked windows and doors, building paper used under siding ○	Caulking in poor repair, building needs paint ✓	No indication of building paper, evident cracks around door and window frame ○

FILL IN AT JOB SITE

MULTIPLY the number of check marks in the first column by 1, the second column by 2, and the third column by 3. The Draft Index will be the sum of these products, divided by 4.

7392 cu.ft. (Volume) X 1.8 (Draft Index) X 2 (District Heating Factor) X .02 = 532 Heating Units Now Required

Potential Savings by Reducing Infiltration

It should be possible to reduce the draft index for a building to 1 (that is reduce the number of air changes to one per hour). If the draft index for this building was improved to 1, the infiltration loss would be:

7392 cu.ft. (Volume (from above)) X 1 (Draft Index) X 2 (District Heating Factor) X .02 = 296 Potential Heating Units

Subtract the potential heating units from those now required and enter here → 236

TYPE OF HEAT LOSS	HEATING UNITS REQUIRED	POTENTIAL HEATING SAVINGS	PROPOSED CHANGES TO STRUCTURE	HEATING UNITS TO BE SAVED
INFILTRATION	532	236		

HEAT LOSSES BY CONDUCTION THROUGH FLOORS

Floor Exposure Factor

Select the appropriate factor from the descriptions below:

☐ Building on posts or pillars with no skirts below floor	1.0
☐ Crawl space skirted	0.8
☐ Rock wall basement	0.8
☑ More than two feet of basement wall exposed above grade	0.8
☐ Building on slab	0.5
☐ Building with tight crawl space	0.5
☐ Building with tight basement (heated or unheated)	0.5

'R' Value of Floor

List below all materials in floor deck, including carpet but neglecting floor joists, starting from inside surface and working down.

Insert 'R' value for each component from Table I

Material	Thickness	'R' Value
Interior Surface	---	.68
LINOLEUM		.08
PLYWOOD	1/2"	.65
SUB-FLOOR	5/8"	1.00
Interior Surface	---	.68

FILL IN AT JOB SITE

924 sq.ft. (Floor Area (from Building Description)) X 0.8 (Floor Exposure Factor) X 2 (District Heating Factor) ÷ 3.1 (Total 'R' Value) = 477 (Heating Units Required)

Potential Savings on Floor Heat Losses

Floors can sometimes be insulated to reduce heat loss but this is often difficult, and where water pipes are below the floor may cause freezing problems during very cold spells. However, every floor should be protected from drafts, etc., so that it has a floor exposure factor of 0.5. With this exposure factor for this building, the heat loss through the floor would be:

924 sq.ft. (Floor Area From Above) X 0.5 (Floor Exposure Factor) X 2 (District Heating Factor) ÷ 3.1 ('R' Value from Above) = 299 (Potential Heating Units)

Subtract the potential heating units from those now required and Enter Here → 178 (Potential Heating Savings)

TYPE OF HEAT LOSS	HEATING UNITS REQUIRED	POTENTIAL HEATING SAVINGS	PROPOSED CHANGES TO STRUCTURE	HEATING UNITS TO BE SAVED
CONDUCTION THRU: FLOORS	477	178		

HEAT LOSSES BY CONDUCTION THROUGH CEILINGS

Area of Ceiling

(Take area of upstairs ceiling in a two-story house)

Ceiling area will normally be the same as floor area (from building description sheet)

Material	Thickness	'R' Value
Inside Surface	---	.68
GYPSUM BOARD	3/8"	.32
FIBERGLASS	2"	7.40
Inside Surface (.68) OR Outside Surface (.17)	---	.68

Distance between joists/rafters: 16"

FILL IN AT JOB SITE

924 sq.ft. (Ceiling Area) X 2 (District Heating Factor) ÷ 9.1 (Total 'R' Value) = 203 (Heating Units Required)

Potential Savings by Insulation of Ceilings

A well insulated ceiling (with 6 inches of insulation) should have an 'R' value of 20. If this was so for this building, the ceiling heat loss would be:

924 sq.ft. (Ceiling Area) X 2 (District Heating Factor) ÷ 20 ('R' Value) = 93 (Potential Heating Units)

Subtract the potential heating units from those now required and Enter Here → 110 (Potential Heating Savings)

TYPE OF HEAT LOSS	HEATING UNITS REQUIRED	POTENTIAL HEATING SAVINGS	PROPOSED CHANGES TO STRUCTURE	HEATING UNITS TO BE SAVED
CONDUCTION THRU: CEILINGS	203	110		

HEAT LOSSES BY CONDUCTION THROUGH SINGLE GLASS WINDOWS
(Assuming R = 1 for single glass)

Area of Single Glass Windows:

If none, enter 0 and go to next sheet on double windows and doors

Width	x Height	x Number	= Area
5	4	1	20
3	4	4	48

TOTAL 68 sq.ft. X 2 (District Heating Factor) = 136 (Heating Units Required)

Potential Saving by Double Glazing

Double glazing or adding storm windows will cut the heat loss by half, so divide heating units by two, and Enter Here → 68 (Potential Heating Savings)

TYPE OF HEAT LOSS	HEATING UNITS REQUIRED	POTENTIAL HEATING SAVINGS	PROPOSED CHANGES TO STRUCTURE	HEATING UNITS TO BE SAVED
CONDUCTION THRU: SINGLE-GLASS WINDOWS	136	68		

HEAT LOSSES BY CONDUCTION THROUGH DOUBLE GLASS OR
PLASTIC COVERED WINDOWS AND THROUGH DOORS
(Assuming R = 2 for these units)

Area of Double Glass and Doors

Width	x Height	x Number	= Area
3	7	2	42
6	4	1	24
3	4	2	24

TOTAL 90 sq.ft X 2 (District Heating Factor) ÷ 2 ('R' Value) = 90 (Heating Units Required)

Potential Savings

Triple glazing of windows can be done but is not usually practical. If no change is made in the windows, the Potential Saving will be 0 heating units and should be entered here → 0 (Potential Heating Savings)

(If windows are triple glazed, the "R" value will be approx. 3 and the Potential Savings will be one-third of the "Heating Units Required.")

TYPE OF HEAT LOSS	HEATING UNITS REQUIRED	POTENTIAL HEATING SAVINGS	PROPOSED CHANGES TO STRUCTURE	HEATING UNITS TO BE SAVED
CONDUCTION THRU: DOORS & DOUBLE-GLASS WINDOWS	90	0		

HEAT LOSSES BY CONDUCTION THROUGH WALLS

Total Perimeter of Outside Wall: 122 ft.

X

Total Height of Outside Wall: 8 ft.

=

Gross Wall Area: 976 sq.ft.

—

Total Area of all Windows and Doors (from previous two pages): 158 sq.ft.

=

Net Wall Area: 818 sq.ft.

'R' Value of Outside Walls

List below all materials in walls, starting from inside and including air spaces within the wall. Insert 'R' value for each component from Table I.

Material	Thickness	'R' Value
Inside surface	---	.68
GYPSUM BOARD	3/8"	.32
AIR SPACE	3/4"	.91
FIBERGLASS	2"	7.40
AIR SPACE	3/4"	.41
SHEATHING	5/8"	1.00
ASBESTOS SHINGLES	1/4"	.13
Outside surface	---	.17

FILL IN AT JOB SITE

818 sq.ft. × 2 (District Heating Factor) ÷ 11.0 (Total 'R' Value) = 148 Heating Units Required

Potential Savings by Insulation

Well insulated walls should have an 'R' value of 15. If this was so for this building, the wall heat loss would be:

818 (Net Wall Area from box above) × 2 (District Heating Factor) ÷ 15 ('R' Value) = 109 Potential Heating Units

Subtract the potential heating units from those now required and Enter Here..... 39

Potential Heating Savings

TYPE OF HEAT LOSS	HEATING UNITS REQUIRED	POTENTIAL HEATING SAVINGS	PROPOSED CHANGES TO STRUCTURE	HEATING UNITS TO BE SAVED
CONDUCTION THRU: WALLS	148	39		

③ Use the instructions on page 11 of the FEA Winterization Manual to assess which potential savings can be obtained most successfully.

④ Fill out the following Summary Table by entering the "Heating Units Required" and the "Potential Heating Savings" from the corresponding tables at the bottom of pages 2 through 7. Then, write in the "Proposed Changes" and "Heating Units to be Saved" by such changes.

HEAT REQUIREMENT ESTIMATES (Annual Heating Units Needed)

TYPE OF HEAT LOSS		HEATING UNITS REQUIRED	POTENTIAL HEATING SAVINGS	PROPOSED CHANGES TO STRUCTURE	HEATING UNITS TO BE SAVED
INFILTRATION	From Page 2	532	236	CAULK & WEATHERSTRIP ALL DOORS & WINDOWS	236
CONDUCTION THRU: FLOORS	Page 3	477	178	CAULK BASEMENT BANK WALL	178
CONDUCTION THRU: CEILINGS	Page 4	203	110	ADD 4" INSULATION	110
CONDUCTION THRU: SINGLE-GLASS WINDOWS	Page 5	136	68	ADD PLASTIC STORM WINDOWS	68
CONDUCTION THRU: DOORS & DOUBLE-GLASS WINDOWS	Page 6	90	0	NONE	0
CONDUCTION THRU: WALLS	Page 7	142	39	NONE - WALLS CLOSED	0
	TOTALS	1580	631		592

⑤ Use the space below to calculate the quantities and cost of materials needed to make the proposed changes to the building.

INSULATION
CEILING - 924 sq ft - ORDER 1000 sq. ft.

PLASTIC STORM WINDOWS
5' WIDE PLASTIC 4 × 3' = 12'
1 × 5' = 5'
17' - ORDER 20' + TAPE

BANKING
4' WIDE PLASTIC 33' + 28' + 33' = 94' - ORDER 100' + TAPE

WEATHERSTRIP
2 DOORS - 7' x 3' 17' EACH x 2 = 34' ORDER 35'

CAULK
AROUND 8 WINDOWS & 2 DOORS = 122' + BASEMENT - ORDER 5 TUBES

⑥ Fill in job sheet on opposite page.

JOB SHEET A

THIS PAGE IS REMOVABLE FOR USE AT JOB SITE

Name MARY PERKINS

Address 3 PINE STREET BANGOR, ME

Type of Materials	Quantity Required	Estimated Cost	Location Where Materials Are To Be Installed (Walls, Ceiling, etc.)	Installation Diagram No.	Special Instructions
4" INSULATION 16"- W/O VB	1000 SQ FT	70.00	CEILING	I-3	TAKE SHEARS & STEPLADDER
POLYETHYLENE 4 MIL. - 4' WIDE	100 FT.	16.00	BANKING	B-1	
POLY. 4 MIL. 5' WIDE	20 FT.	4.00	WINDOWS	P-1	NEED KNIFE & STAPLER
2" MASKING TAPE	3 ROLLS	6.00	BANKING & WINDOWS	B-1 & P-1	
CAULKING COMPOUND	6 TUBES	6.00	WINDOW & DOOR FRAMES	C-1	NEED CAULKING GUN
WEATHER STRIP VINYL TUBING	35 FT	3.00	DOORS	S-2 & S-4	NEED HAMMER

(INSERT CARBON PAPER UNDER TABLE AT TOP OF PAGE ONLY)

Map or directions for locating home:

ROUTE 222 FROM CENTER OF TOWN 1.5 MILES
FIRST HOUSE ON LEFT AFTER CROSSING BRIDGE

FILL IN AT JOB SITE

WORK RECORD

Activity	Date	Supervisor	Comments
Order Materials	5/10/75	E. Hall	All Materials Ordered
Install Materials	6/1/75	S. Paul	Doors Not Weatherstripped

JOB SHEET B

THIS PAGE IS RETAINED WITH JOB BOOK AS PERMANENT RECORD

Type of Materials	Quantity Required	Estimated Cost	Location Where Materials Are To Be Installed (Walls, Ceiling, Etc.)	Installation Diagram No.	Special Instructions
4" INSULATION 16" o/c U.E.	1008 SQFT	70.00	CEILING	I-3	TAKE SHEARS & STEPLADDER
POLYETHYLENE 4 MIL x 4' WIDE	100 FT	16.00	BANKING	B-1	
POLY. 4 MIL. 6' WIDE	20 FT	4.00	WINDOWS	P-1	NEED KNIFE & STAPLER
2" MASKING TAPE	3 ROLLS	6.00	BANKING & WINDOWS	B-1 & P-1	
CAULKING COMPOUND	6 TUBES	6.00	WINDOW & DOOR FRAMES	C-1	NEED CAULKING GUN
WEATHER STRIP VINYL TUBING	35 FT	8.00	DOORS	S-2 & J-4	NEED HAMMER
		Total Cost 105.00			

(7) PAY-OFF TIME

This is the number of seasons for fuel savings to pay off the cost of winterization.

$$\frac{\text{105.00}}{\text{Total Cost (from job sheet above)}} = \text{.44 YRS.} \quad \text{GOOD INVESTMENT!}$$

("Pay-off" Time (seasons))

$$\text{1} \times \text{592} \times \text{.40}$$

- 1 — Fuel Factor: Fuel Oil = 1, Natural Gas = 120, Electricity = 30
- 592 — Total Heating Units Saved (From page 8)
- .40 — Price of Fuel Per gal, cu.ft., KWH

DISTRICT HEATING FACTOR

Northeastern United States

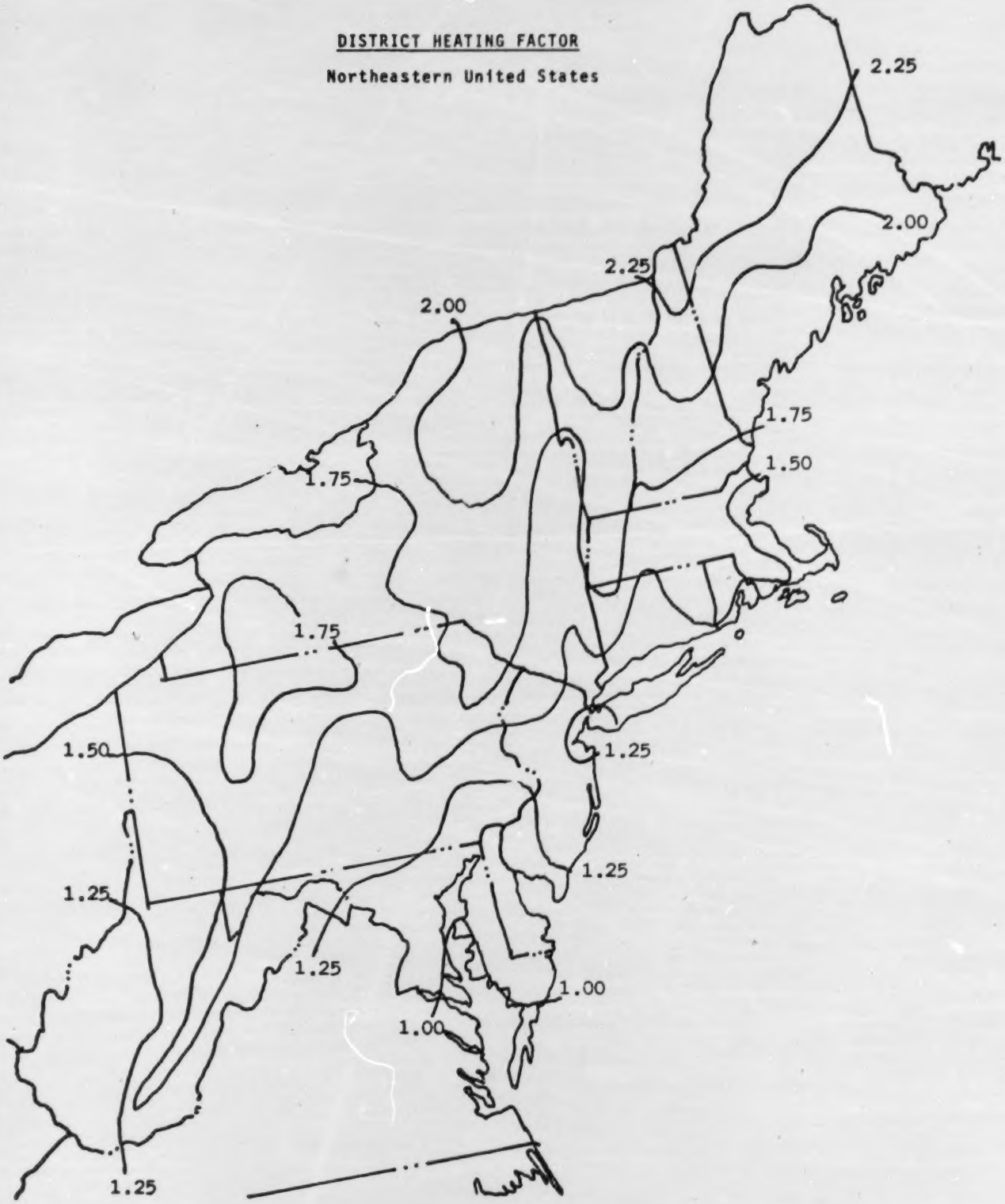


TABLE I. INSULATION VALUE OF COMMON MATERIALS

Source: ASHRAE Guide and Data Book

MATERIAL	THICKNESS	'R' VALUE
Air Film and Spaces		
Air space, bounded by ordinary materials	3/4" or more	0.91
Air Space, bounded by aluminum foil	3/4" or more	2.17
Exterior surface resistance	- -	0.17
Interior surface resistance	- -	0.68
Masonry		
Sand and gravel concrete block	8"	1.11
Sand and gravel concrete block	12"	1.28
Lightweight concrete block	8"	2.00
Lightweight concrete block	12"	2.13
Face brick	4"	0.44
Concrete cast in place	8"	0.64
Building Materials - General		
Wood sheathing or subfloor	3/4"	1.00
Fiber board insulating sheathing	3/4"	2.10
Plywood	5/8"	0.79
Plywood	1/2"	0.63
Plywood	3/8"	0.47
Bevel lapped siding	1/2" x 8"	0.81
Bevel lapped siding	3/4" x 10"	1.05
Vertical tongue and groove board	3/4"	1.00
Drop siding	3/4"	0.94
Asbestos board	1/4"	0.13
3/8" gypsum lath and 3/8" plaster	3/4"	0.42
Gypsum board	3/8"	0.32
Interior plywood panel	1/4"	0.31
Building paper	--	0.06
Vapor barrier	--	0.00
Wood shingles	--	0.87
Asphalt shingles	--	0.44
Linoleum	--	0.08
Carpet with fiber pad	--	2.08
Hardwood floor	--	0.71
Insulation Materials (mineral wool, glass wool, wood wool, etc.)		
Blanket or batts	1"	3.70
Blanket or batts	3 1/2"	11.00
Blanket or batts	6"	19.00
Loose fill	1"	3.33
Rigid insulation board (sheathing)	3/4"	2.10
Windows and Doors		
Single window	--	Approx. 1.00
Double window	--	Approx. 2.00
Exterior door	--	Approx. 2.00

HOME WINTERIZATION: STEP 4 - INSTALLATION OF MATERIALS

Before attempting to apply winterization materials, make sure that you have the right material for the job and the proper equipment for installation. Ladders, step ladders, hammers, staplers, caulking guns, putty knives, utility knives, measuring tapes, saws and shears are needed to apply winterization materials. Determine what needs to be done in applying the material and make sure the equipment is available.

Storm Windows and Doors

How you install plastic over windows and doors depends upon the type of plastic you are installing. Polyethylene film will last only one year so it is not necessary to apply the material on an elaborate framing since it will be removed after one year. Vinyl film, on the other hand, will last several years and probably can best be used by building light frames, either for the door or window, and installing the plastic over the frames. For installing polyethylene film, cut the film to the desired size and apply over the window frame, using laths and nails, staples, or tape, as shown in figures P-1 and P-2. Tape is generally satisfactory for one year and does not leave holes in the framing members. Before applying tape over windows and door frames, make sure that they are clean and free from flaking paint. Masking tape or plastic tape is generally satisfactory for applying polyethylene over windows and door frames. Light frames for applying clear vinyl can be made out of 1" x 2" strapping, joining the corners either with a half lap joint or corrugated fasteners and applying the plastic over the frame with lath and nails. See pages 22-25 for step-by step instructions.

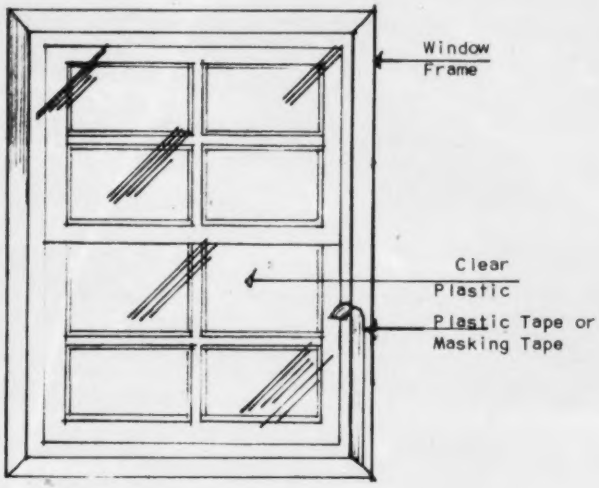


Figure P-1

PLASTIC STORM WINDOW USING TAPE

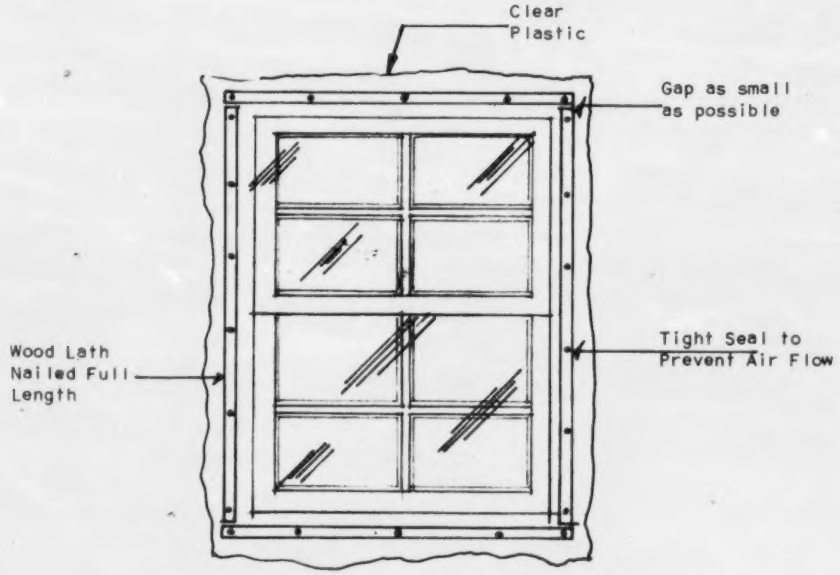


Figure P-2 PLASTIC STORM WINDOW USING LATH AND NAILS

Caulking

Caulking compound is available in eleven ounce cartridges, in bulk, for use in caulking guns, or preformed into a rope or cord for application by hand. Caulking compound ordinarily is of the oil base type. However, it is available in latex or butyl rubber base. The rubber base caulking compounds remain flexible and will not dry out, and are particularly useful where surfaces will move in relation to each other. Do not use caulking compound between surfaces that are to be moved, such as the window sash and window frame. Use weatherstripping in areas where one surface has to be moved. The preformed type of caulking compound is more fibrous and easier to use in filling large openings.

Apply caulking compound only during warm weather. The temperature should be above 40 degrees and the materials should be kept warm to be workable. The surfaces should be clean and dry, free from flaking paint and loose dirt. Force the caulking material into the crack or opening and smooth out the material, either with your hand or a putty knife. On bare wood, the material adheres better if you prime the material with linseed oil or paint. Do not attempt to apply caulking compound during cold weather since the material will become stiff and difficult to work.

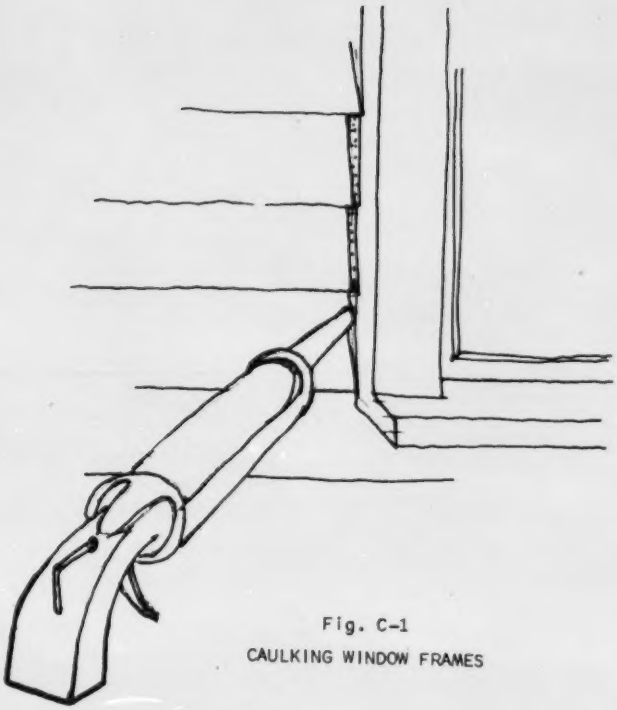


Fig. C-1
CAULKING WINDOW FRAMES

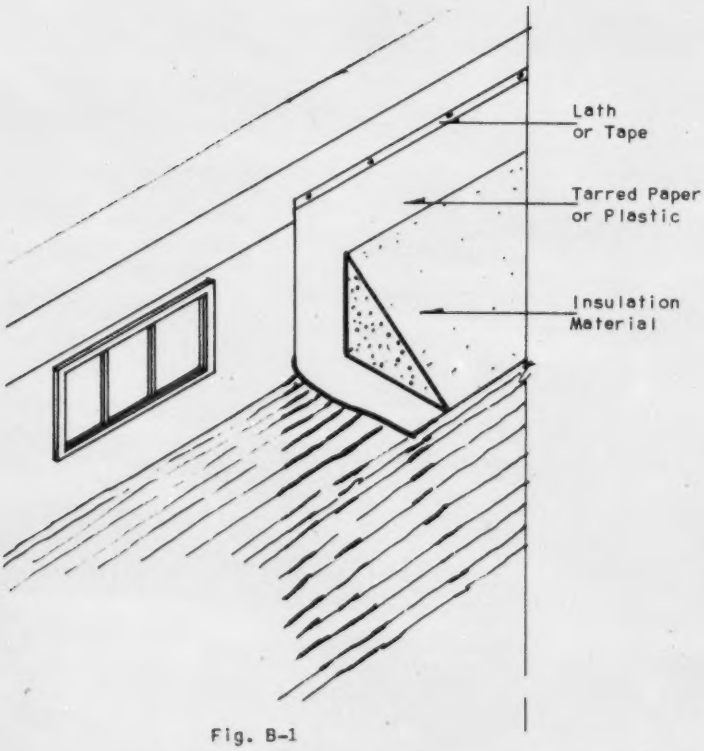


Fig. B-1
SHOWING INSTALLATION OF
BANKING MATERIALS

Banking Materials

When banking house foundations, the most important material is the paper or plastic to keep out the air infiltration into the space below the floor. Usually three foot wide material is sufficient to reach from the siding to the ground level. Unroll the material around the side of the house, allowing it to lap down on the ground at least one foot. Polyethylene film or tarred paper is satisfactory for this type of banking material. Fasten the material to the sidewall of the house, using laths and nails or tape. Tarred paper is usually applied with laths and nails. Plastic can be applied either with laths and nails or tape. Some types of siding material, such as cement asbestos siding, aluminum or vinyl siding, nails and laths cannot be used. Masking tape or plastic tape can be used to fasten the banking material to the siding.

If insulating material is to be added to the foundation, pile the insulating material in the corner between the foundation and the ground line. If sawdust, shavings, or hay is used, it is usually a good idea to cover the material with plastic after it is applied to keep it from getting wet. Boards or 2 x 4's can be used to lay over the plastic to keep it in place. The banking material should be removed in the spring to allow the siding and framing of the house to dry out since moisture tends to collect behind the plastic or tarred paper.

Applying Insulation

In applying blanket type of insulation, cut the blanket or batt to a length to fit the opening where it is to be installed. If the blanket has a vapor barrier, be sure to apply the vapor barrier on the warm side of the insulation. If two pieces of insulation are to be joined in the framing space, make sure the joint is tight to prevent air leakage. Fit the blanket insulation into the framing space and staple in place. If the vapor barrier is of the kraft type, staple the vapor barrier flush with the face of the framing member as shown in Figure I-1. If the vapor barrier is of the aluminum foil type, recess the insulation into the framing space and staple into the sides of the framing members. Do not use insulation with a vapor barrier when re-insulating over an already insulated area. Insulation without a vapor barrier is available for this type of installation. Blanket insulation with kraft vapor barrier is usually the most economical.

When installing loose fill insulation, pour the material onto the surface or into the wall cavity until the area is full. If you are pouring into a vertical wall, settle the material with a piece of strapping or broom handle to make sure that no voids are in the insulation. Be careful not to allow voids to form below windows, doors, or fire stops. Leave access to vertical wall spaces so that the insulation can be refilled after it settles. When installing fill type insulation onto ceiling areas, pour the insulation onto the top of the framing members and level with a rake or board to the desired thickness.

Follow manufacturers instruction when applying insulation around electrical fixtures. Observe safety precautions printed on the package label.

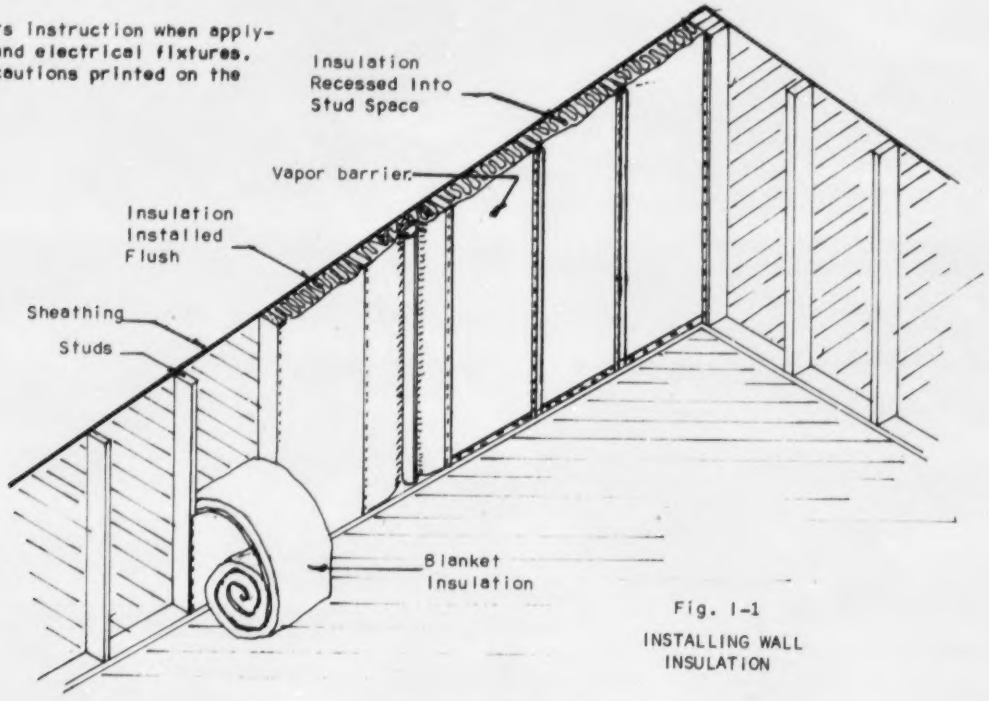
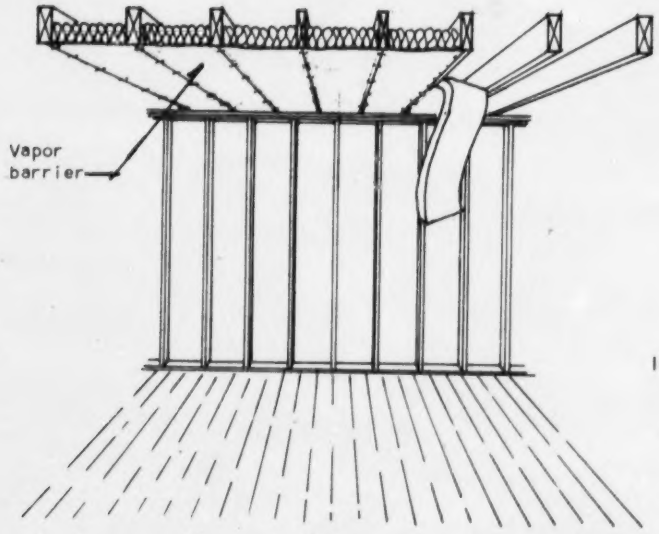


Fig. I-1
INSTALLING WALL INSULATION



Note: When adding more insulation, never put a vapor barrier next to existing insulation. If rolls or batts being added have a vapor barrier, remove it or slash it thoroughly before installation.

Fig. I-2
INSTALLING CEILING INSULATION

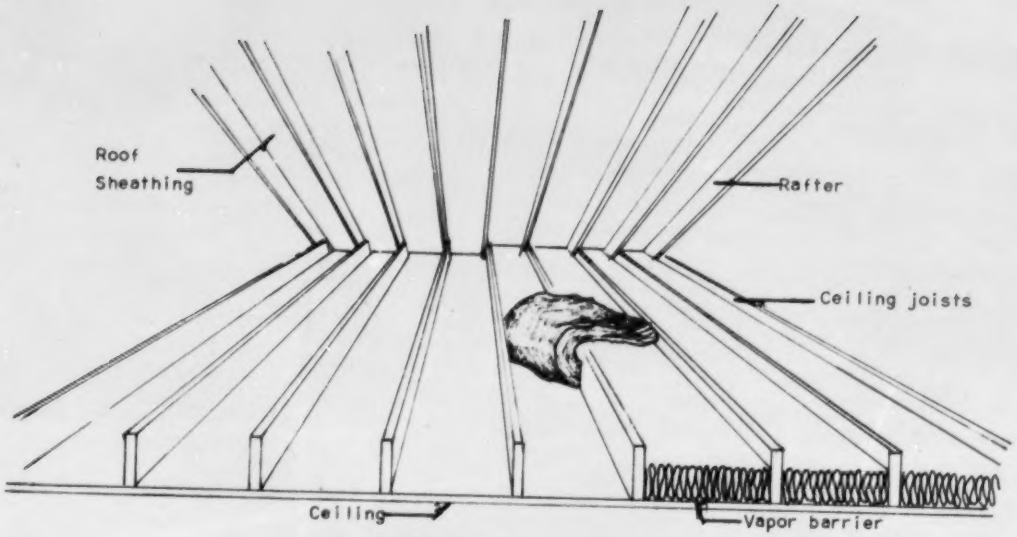


Fig. I-3
INSULATING CEILING
FROM ATTIC

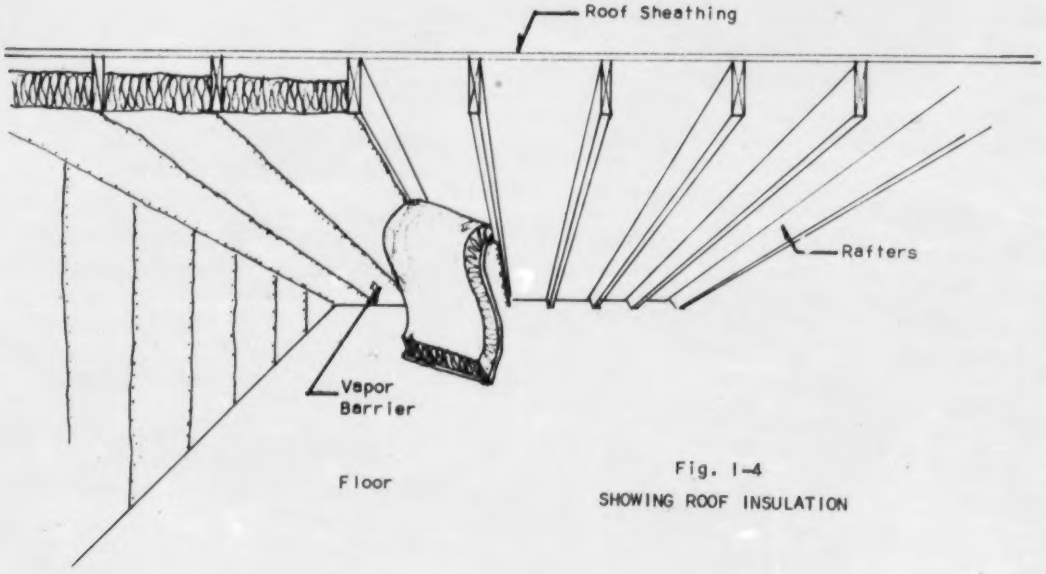


Fig. I-4
SHOWING ROOF INSULATION

WEATHERSTRIPPING

Weatherstripping materials vary considerably, depending on the type of material and location it is to be used. The illustrations listed below describe the application of most commonly available materials and their relative ease of use.

DOOR SILLS

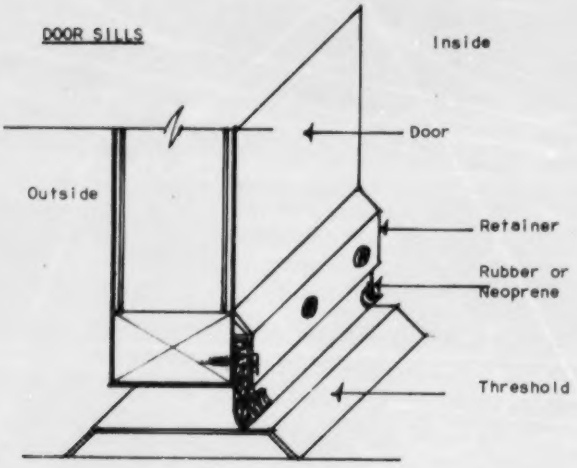


Fig. S-1

Rubber or neoprene strips seal the bottom of the door, and can be installed without removing the door. This seal can also be fashioned from the heavy rubber weatherstripping used to seal around overhead garage doors or can be cut from a truck tire flap. These heavy rubber seals can be nailed directly to the door without using a retainer.

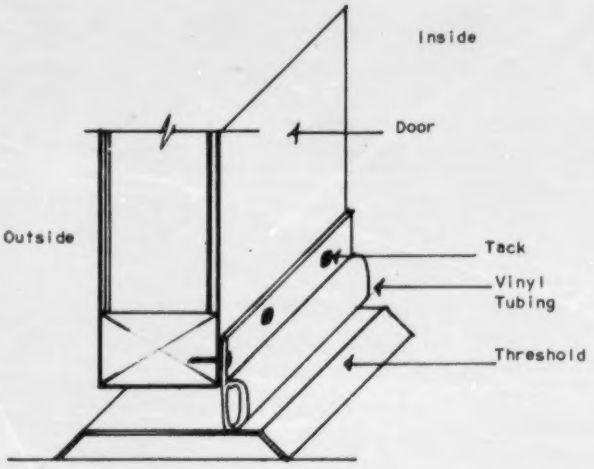


Fig. S-2

Vinyl tubing also allows installation without removing the door. The tubing can be bought hollow or with foam rubber in the cavity, and can be tacked or stapled to the door.

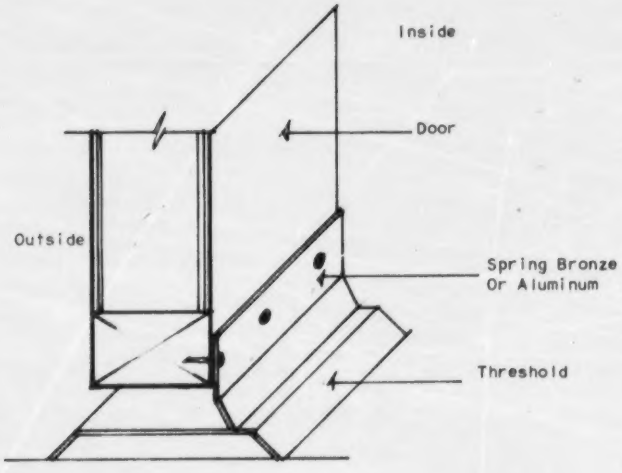


Fig. S-3

Metal strips are spring bronze, aluminum and stainless steel. In general, this type is less satisfactory and more expensive than S-2 (doors must be removed for installation and made parallel with sill; metal may scratch floor).

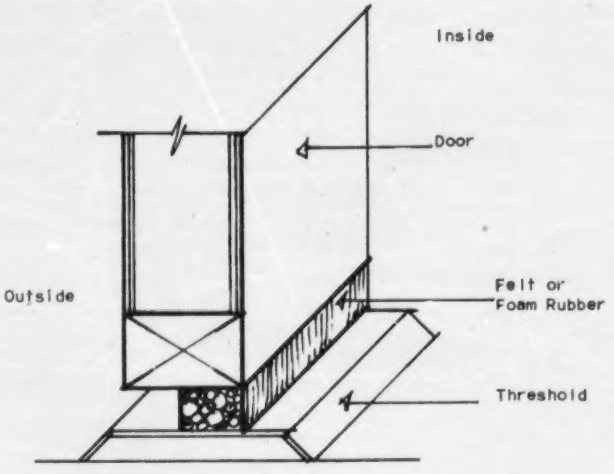


Fig. S-4

Felt or foam rubber strip may be attached to the bottom of the door. The strip can be tacked or stapled. Foam rubber strips can also be bought with self-stick backing. While this may be the cheapest material, it requires removal of the door.

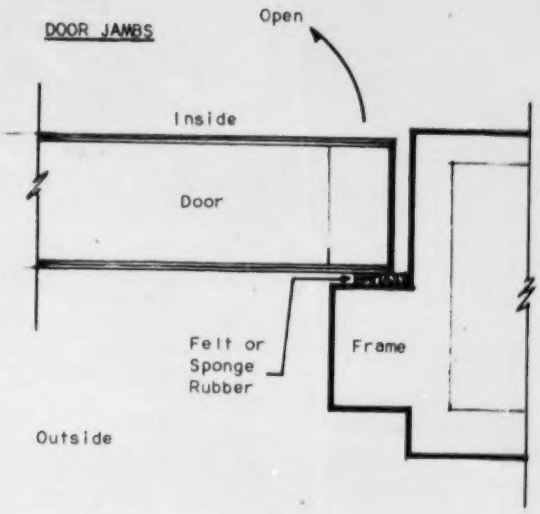


Fig. J-1

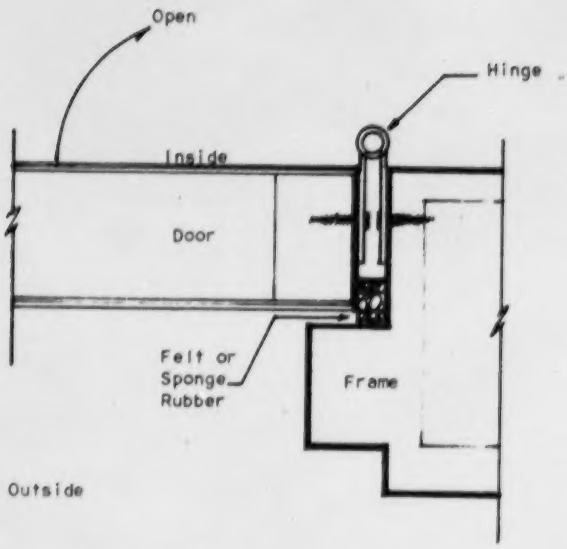


Fig. J-2

Felt or foam rubber can be glued, stapled or tacked to the door frame. Door removal is not required.

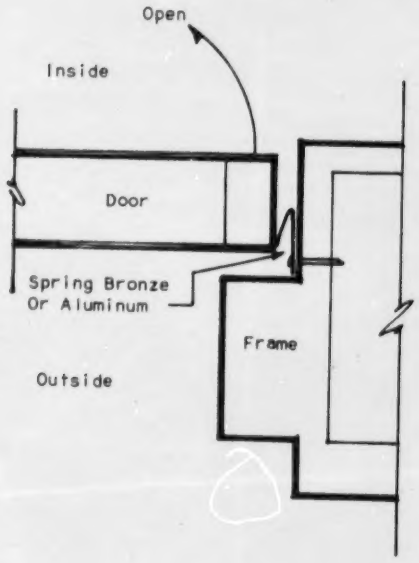


Fig. J-3

A spring metal clip may be more expensive than the solutions in J-1 and J-2, but the metal won't tear like the foam rubber will. If possible, the weatherstripping should be applied so that the air flow tends to make the seal tighter. The air flows through the crack from the bottom of the figure to the top and forces the metal against the door.

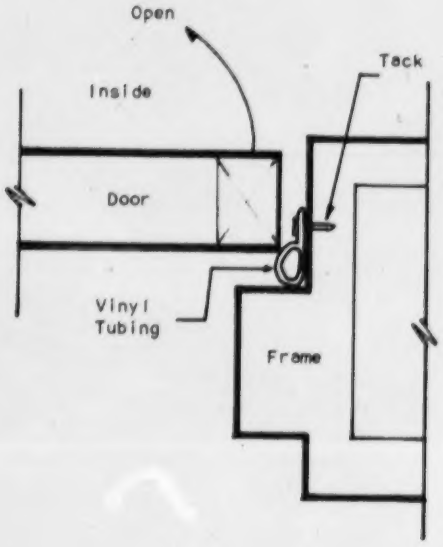


Fig. J-4

Vinyl tubing can be either tacked or stapled to the door frame. This is almost as inexpensive as the felt shown in Figures J-1 and J-2.

Plastic neoprene or felt and retainer similar to that of Fig. S-1 may also be used. A retainer can be a strip of wood.

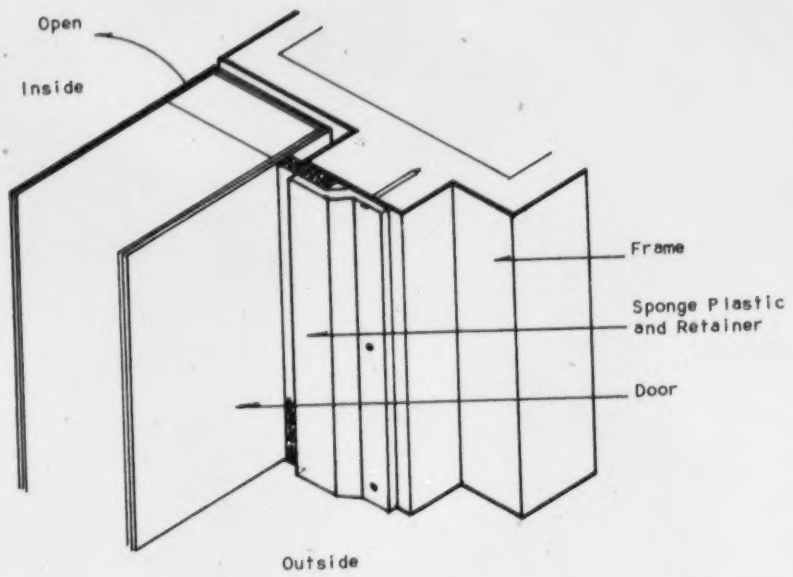


Fig. J-5

WINDOWS

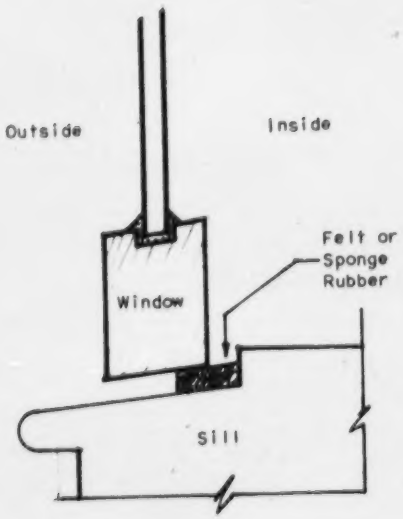


Fig. W-1

Felt or sponge rubber can be stapled, tacked, or glued to a window sill.

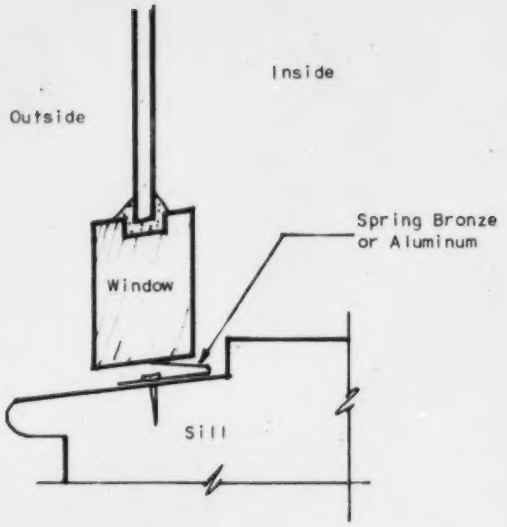


Fig. W-2

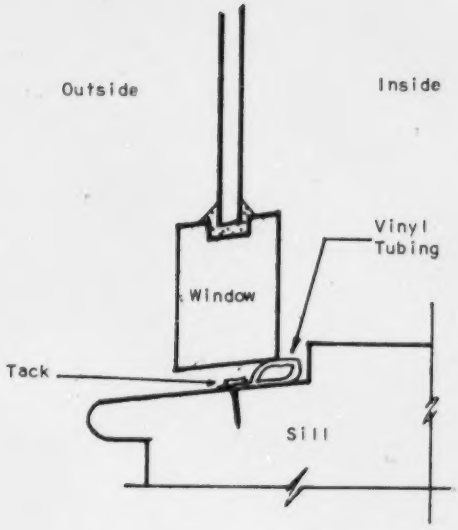


Fig. W-3

Vinyl tubing and spring metal can be installed. A cold draft coming in from the outside makes the seal tighter.

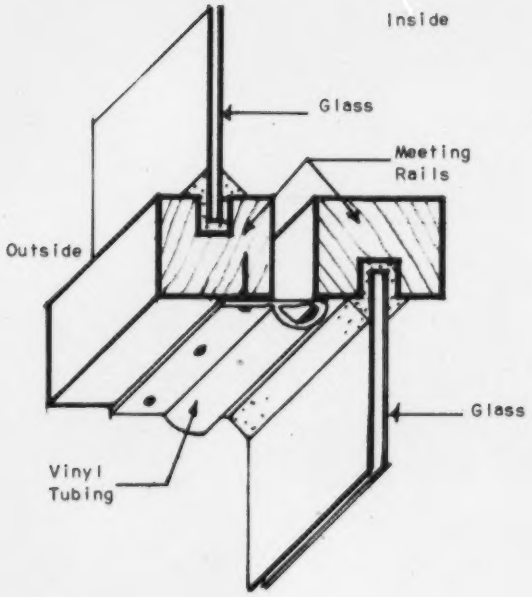


Fig. W-4

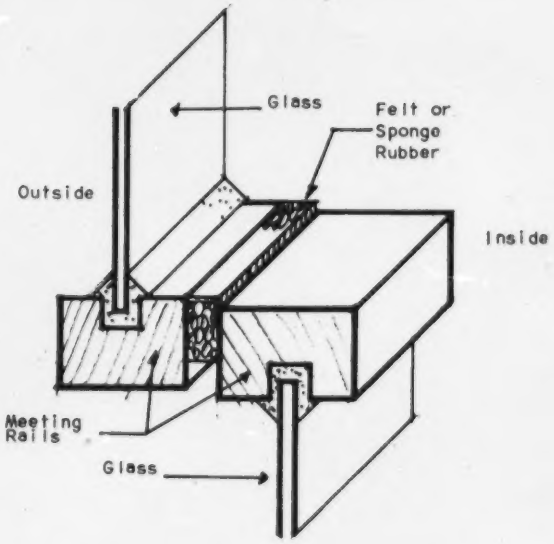


Fig. W-5

Weatherstripping can be installed along the meeting rails of a double-hung window.

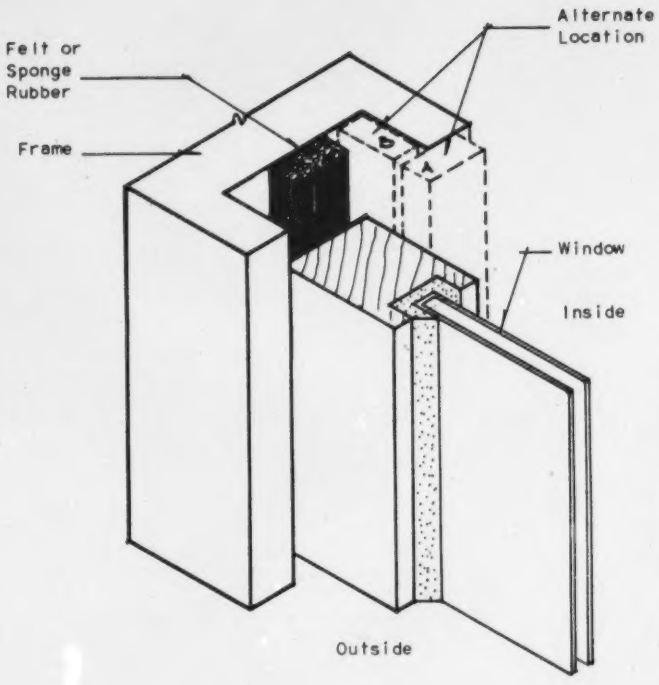


Fig. W-6

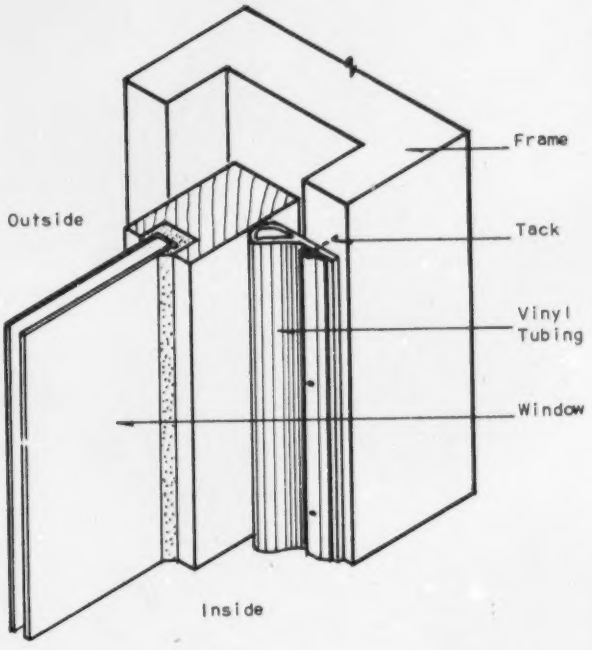


Fig. W-7

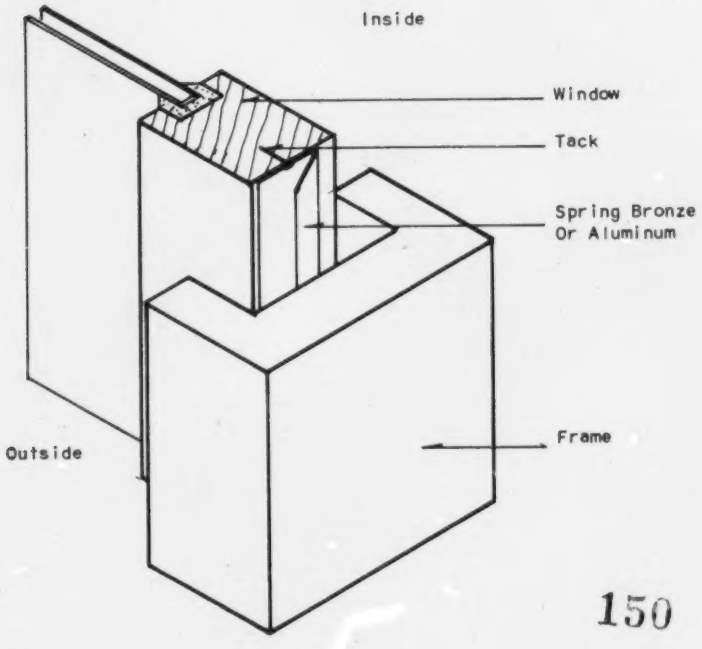


Fig. W-8

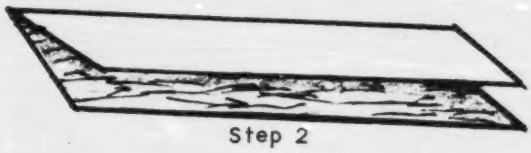
Fig. W-7 and alternate location A in Fig. W-6 do not require removal of the window. The metal strip shown in Fig. W-8 is expensive and requires removing the window.

HOW TO MAKE PLASTIC STORM WINDOWS

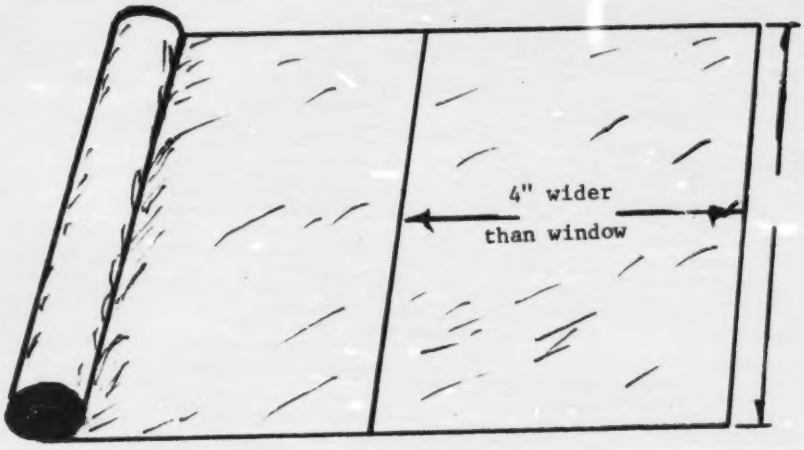
Step 1

Step 1. Measure the area to be covered--length and width. Write this down or you will forget it.

Step 2. Cut a piece of tarred paper two inches wide and as long as the window. Fold into 'V'.

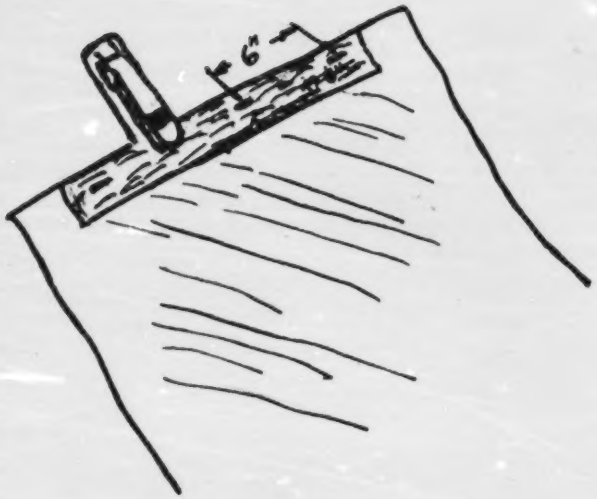


Step 2



Step 3

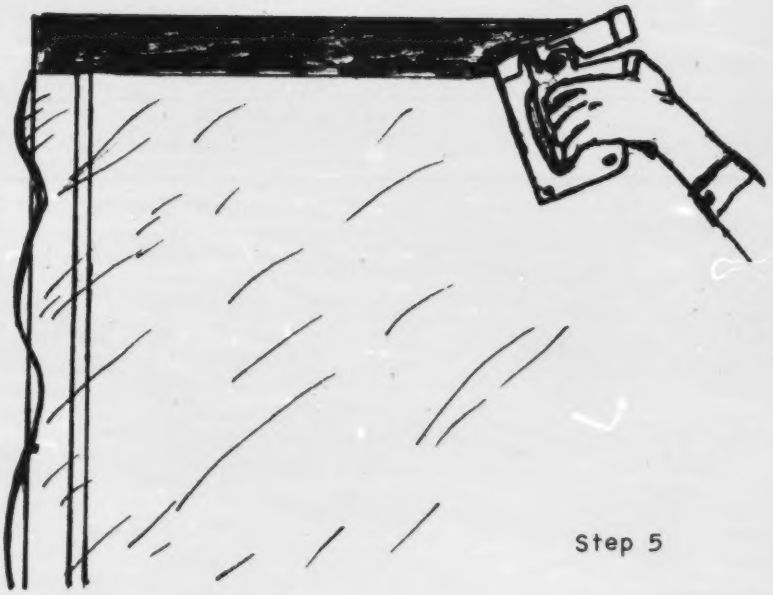
Step 3. Cut a piece of plastic four inches wider than the window and as long as the plastic is wide. The part left over will be used on another window. Keep cutting plastic as square as possible--there will be less waste this way.



Step 4

Step 4. Using an office type staple machine, staple plastic into 'V' of tarred paper.

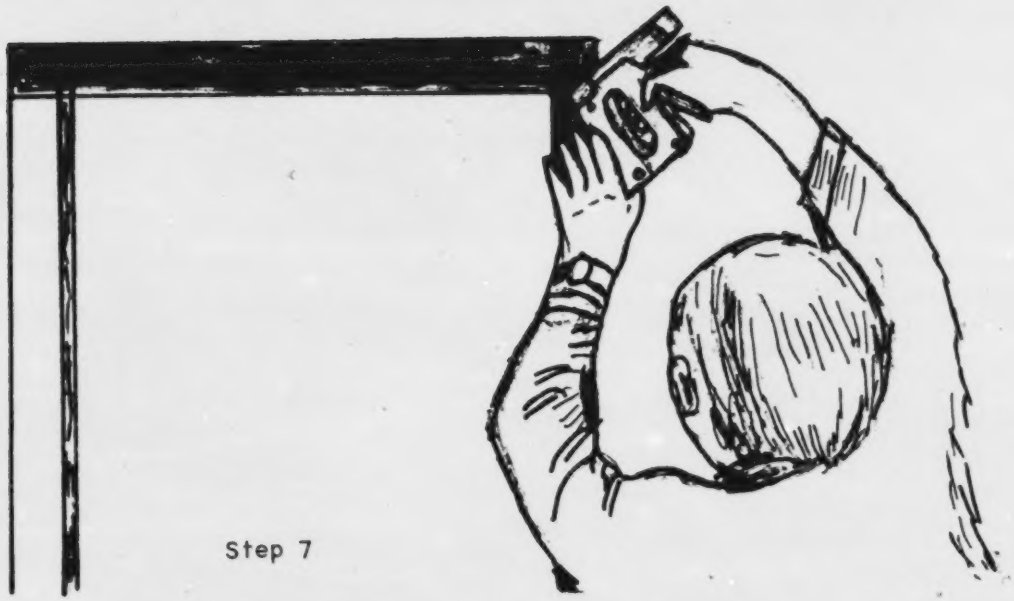
Step 5. Use staple gun to fasten tarred paper and plastic to the window.



Step 5

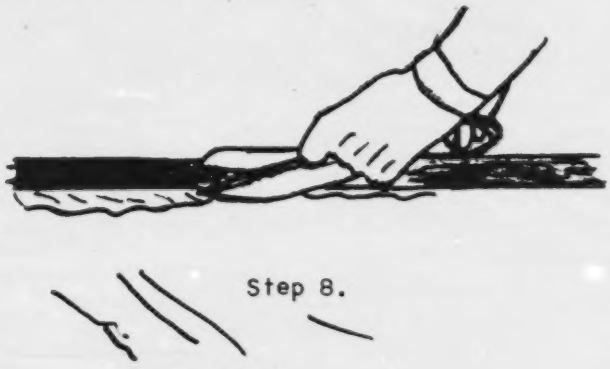
Step 6

Step 6. Cut two strips of tarred paper 3/4 inches wide and as long as the window--another as wide as the window. Cut with retractable blade knife and use a straight edge--don't guess.



Step 7

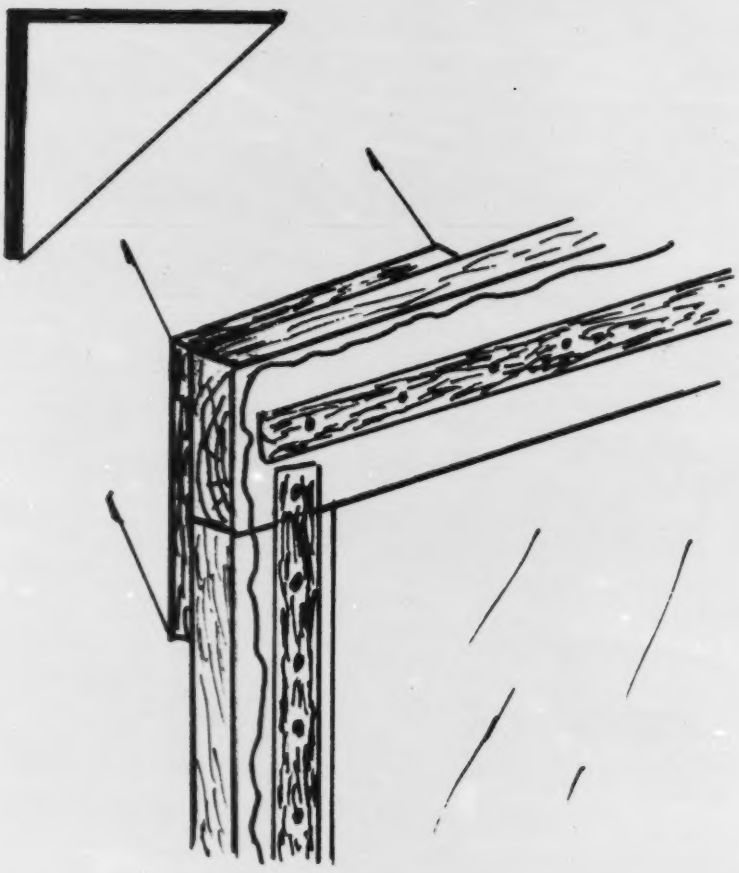
Step 7. Start at the top and work down stapling the plastic (double back for two thicknesses) to the window through the strips of tarred paper. Staples every six inches in windy locations are plenty. Pull as much of the sag out of the plastic as possible as you go.



Step 8.

Step 8. Trim off the excess plastic.

At the end of the season the staples can be removed and the plastic stored by rolling on the'V' shaped tarred paper header. Six-year life for one sheet of 4 mil plastic is possible. The disadvantage of this system is the damage done by all the staples to the window trim.



A second method would be to make a simple wood frame from lath (1" wide x 3/8" thick) Staple the plastic to it (the tarred paper strip is a good idea); then use four 2 penny nails to hold this to the window frame. This system is a little more difficult to make and store, but does less damage to the building.

DISTRICT HEATING FACTOR

UNITED STATES

155

156

TYPICAL COST OF MATERIALS					
Material	Type	Unit Size	Unit Cost	Local Vendor	Date
Mineral Wool	16" Batt	8 ft.			
" "	Loose	Cu. ft.			
Storm Window	Glass				
"	Plastic film				
Weatherstrip					
Caulking					
Strapping					
Heating Oil		Gal			
Electricity		KWH			
Natural Gas		Cu. ft.			
Bottled Gas					
Kerosene		Gal			
Coal/Coke		Ton			
Wood		Cord	157		

☆U.S. GOVERNMENT PRINTING OFFICE: 1975—A-0268/148

Federal Energy
Administration

Washington
D.C. 20461

PROJECT
RETRO-TECH

Home Winterization Job Book for

Name: _____

Address: _____

_____

WORK RECORD

Assignment	Supervisor	Date Completed
HOME EVALUATION:		
Field Inspection (pg. 1-7)	_____	_____
Heat Loss Calculation (pg. 8)	_____	_____
JOB SHEET (pg. 9-10):		
Order Materials	_____	_____
Install Materials	_____	_____

JUNE 1975

DESCRIPTION OF BUILDING

(1) Sketch all views and put dimensions on each part shown, e.g., length of walls, width and length of windows, etc. Label all single glass windows (S) and double glass and doors (D). Complete all items in the Job Book labeled "Fill in at Job Site."

Front View

Right Side View

Left Side View

Rear View

Plan View

Calculation of Floor Area

_____ ft. Building Length X _____ ft. Building Width

= _____ sq.ft. Floor Area

FILL IN AT JOB SITE

DESCRIPTION OF BUILDING
(Continued from Opposite Page)

FILL IN AT JOB SITE

DWELLING UNIT INFORMATION

* NAME OF HEAD OF HOUSEHOLD

_____

* NAME & ADDRESS OF OWNER:
(if not the same as above)

_____

_____

_____

* OCCUPANTS OF STRUCTURE:

Total Number ☐

* STYLE OF STRUCTURE:

☐ One Story ☐ Split-level

☐ Two Story ☐ Other (Specify)

☐ 2 1/2 Story _____

* AGE OF STRUCTURE (Approx): ☐ years

* ROOMS IN LIVING SPACE:

Total Number of Rooms..... ☐

Number Used in Winter..... ☐

* OCCUPANTS COMMENTS (e.g., drafty, cold floors, too expensive to heat, etc.):

_____

_____

_____

_____

HEATING SYSTEM INFORMATION

* TYPE OF FUEL: (P = Primary) (S = Secondary)

☐ Fuel Oil ☐ Natural Gas

☐ Bottled Gas ☐ Wood

☐ Coal/Coke ☐ Kerosene

☐ Electricity ☐ Other (Specify)

_____

* TYPE OF HEATING SYSTEM: (P = Primary) (S = Secondary)

☐ Steam/Hot water/Hot Air

☐ Fireplace/Stove/Portable Heater

☐ Electrical Baseboard

☐ Other (Specify) _____

* DOMESTIC HOT WATER:

Does central heating system provide heat for domestic hot water? _____

* THERMOSTAT SETTING IN WINTER (average):

Day ☐ Night ☐ None ☐

* AMOUNT OF FUEL USED LAST HEATING SEASON:

	Primary	Supplementary
Type	_____	_____
Quantity	_____	_____
Total Cost	$ _____	$ _____

* DISTRICT HEATING FACTOR..... ☐
(from Manual, page 8)

(2) On pages 2 thru 7, calculate the heat loss by Infiltration and by Conduction thru the separate parts of the building, and enter the results in the table at the bottom of each page, and in the Summary Table on page 8.

HEAT LOSS BY INFILTRATION

Volume of Air in building

Floor Area ☐ sq.ft.

X

☐ ft.

Height to ceiling (to upstairs ceiling in two-story house)

=

HOUSE DRAFT INDEX: Opposite each of the four component parts of a building in the table below, place a check mark in the circle adjacent to the features which best describe the condition of the building.

BUILDING COMPONENT	ONE Air Change Per Hour ①	TWO Air Change Per Hour ②	THREE Air Change Per Hour ③
CELLAR or CRAWL SPACE	Tight, no cracks, caulked sills, sealed cellar windows, no grade entrance leaks ○ Plywood floor, no trap door leaks, no leaks around water, sewer and electrical openings	Some foundation cracks, no weather stripping on cellar windows, grade entrance not tight ○ Tongue and groove board floor, reasonable fit on trap doors, around pipes, etc.	Stone foundation, considerable leakage area, poor seal around grade entrance ○ Board floor, loose fit around pipes, etc.
WINDOWS	Storm windows with good fit ○	No storm windows, good fit on regular windows ○	No storm windows, loose fit on regular windows ○
DOORS	Good fit on storm doors ○	Loose storm doors, poor fit on inside door ○	No storm doors loose fit on inside door ○
WALLS	Caulked windows and doors, building paper used under siding ○	Caulking in poor repair, building needs paint ○	No indication of building paper, evident cracks around door and window frame ○

FILL IN AT JOB SITE

MULTIPLY the number of check marks in the first column by 1, the second column by 2, and the third column by 3. The Draft Index will be the sum of these products, divided by 4.

☐ cu.ft. (Volume) X ☐ (Draft Index) X ☐ (District Heating Factor) X .02 = ☐ (Heating Units Now Required)

Potential Savings by Reducing Infiltration

It should be possible to reduce the draft index for a building to 1 (that is reduce the number of air changes to one per hour). If the draft index for this building was improved to 1, the infiltration loss would be:

☐ cu.ft. (Volume (from above)) X 1 (Draft Index) X ☐ (District Heating Factor) X .02 = ☐ (Potential Heating Units)

Subtract the potential heating units from those now required and enter here → ☐

TYPE OF HEAT LOSS	HEATING UNITS REQUIRED	POTENTIAL HEATING SAVINGS	PROPOSED CHANGES TO STRUCTURE	HEATING UNITS TO BE SAVED
INFILTRATION				

HEAT LOSSES BY CONDUCTION THROUGH FLOORS

Floor Exposure Factor

Select the appropriate factor from the descriptions below:

☐ Building on posts or pillars with no skirts below floor	1.0
☐ Crawl space skirted	0.8
☐ Rock wall basement	0.8
☐ More than two feet of basement wall exposed above grade	0.8
☐ Building on slab	0.5
☐ Building with tight crawl space	0.5
☐ Building with tight basement (heated or unheated)	0.5

'R' Value of Floor

List below all materials in floor deck, including carpet but neglecting floor joists, starting from inside surface and working down.

Insert 'R' value for each component from Table I

Material	Thickness	'R' Value
Interior Surface	---	.68
Interior Surface	---	.68

FILL IN AT JOB SITE

[ ] sq.ft. X [ ] X [ ] ÷ [ ] = [ ]

Floor Area (from Building Description) | Floor Exposure Factor | District Heating Factor | Total 'R' Value | Heating Units Required

Potential Savings on Floor Heat Losses

Floors can sometimes be insulated to reduce heat loss but this is often difficult, and where water pipes are below the floor may cause freezing problems during very cold spells. However, every floor should be protected from drafts, etc., so that it has a floor exposure factor of 0.5. With this exposure factor for this building, the heat loss through the floor would be:

[ ] sq.ft. X **0.5** X [ ] ÷ [ ] = [ ]

Floor Area From Above | Floor Exposure Factor | District Heating Factor | 'R' Value from Above | Potential Heating Units

Subtract the potential heating units from those now required and Enter Here → [ ]

Potential Heating Savings

TYPE OF HEAT LOSS	HEATING UNITS REQUIRED	POTENTIAL HEATING SAVINGS	PROPOSED CHANGES TO STRUCTURE	HEATING UNITS TO BE SAVED
CONDUCTION THRU: FLOORS				

HEAT LOSSES BY CONDUCTION THROUGH CEILINGS

Area of Ceiling

(Take area of upstairs ceiling in a two-story house)

Ceiling area will normally be the same as floor area (from building description sheet)

Material	Thickness	'R' Value
Inside Surface	—	.68
Inside Surface (.68) OR Outside Surface (.17)	—	

Distance between joists/rafters: [ ]

FILL IN AT JOB SITE

[ ] sq.ft. (Ceiling Area) X [ ] (District Heating Factor) ÷ [ ] (Total 'R' Value) = [ ] (Heating Units Required)

Potential Savings by Insulation of Ceilings

A well insulated ceiling (with 6 inches of insulation) should have an 'R' value of 20. If this was so for this building, the ceiling heat loss would be:

[ ] sq.ft. (Ceiling Area) X [ ] (District Heating Factor) ÷ [20] ('R' Value) = [ ] (Potential Heating Units)

Subtract the potential heating units from those now required and Enter Here → [ ] Potential Heating Savings

TYPE OF HEAT LOSS	HEATING UNITS REQUIRED	POTENTIAL HEATING SAVINGS	PROPOSED CHANGES TO STRUCTURE	HEATING UNITS TO BE SAVED
CONDUCTION THRU: CEILINGS				

HEAT LOSSES BY CONDUCTION THROUGH SINGLE GLASS WINDOWS
(Assuming R = 1 for single glass)

Area of Single Glass Windows:

If none, enter 0 and go to next sheet on double windows and doors

Width	x Height	x Number	= Area

TOTAL [ ] sq.ft. X [ ] District Heating Factor = [ ] Heating Units Required

Potential Saving by Double Glazing

Double glazing or adding storm windows will cut the heat loss by half, so divide heating units by two, and Enter Here → [ ] Potential Heating Savings

TYPE OF HEAT LOSS	HEATING UNITS REQUIRED	POTENTIAL HEATING SAVINGS	PROPOSED CHANGES TO STRUCTURE	HEATING UNITS TO BE SAVED
CONDUCTION THRU: SINGLE-GLASS WINDOWS				

HEAT LOSSES BY CONDUCTION THROUGH DOUBLE GLASS OR
PLASTIC COVERED WINDOWS AND THROUGH DOORS
(Assuming R = 2 for these units)

Area of Double Glass and Doors

Width	x Height	x Number	= Area

TOTAL ____ sq.ft X ____ ÷ 2 = ____

District Heating Factor | 'R' Value | Heating Units Required

Potential Savings

Triple glazing of windows can be done but is not usually practical. If no change is made in the windows, the Potential Saving will be 0 heating units and should be entered here → ____

(If windows are triple glazed, the "R" value will be approx. 3 and the Potential Savings will be one-third of the "Heating Units Required.")

Potential Heating Savings

TYPE OF HEAT LOSS	HEATING UNITS REQUIRED	POTENTIAL HEATING SAVINGS	PROPOSED CHANGES TO STRUCTURE	HEATING UNITS TO BE SAVED
CONDUCTION THRU: DOORS & DOUBLE-GLASS WINDOWS				

HEAT LOSSES BY CONDUCTION THROUGH WALLS

Total Perimeter of Outside Wall ____ ft.

×

Total Height of Outside Wall ____ ft.

=

Gross Wall Area ____ sq.ft.

−

Total Area of all Windows and Doors (from previous two pages) ____ sq.ft.

=

Net Wall Area ____ sq.ft. × ____ ÷ ____ = ____

District Heating Factor | Total 'R' Value | Heating Units Required

'R' Value of Outside Walls

List below all materials in walls, starting from inside and including air spaces within the wall. Insert 'R' value for each component from Table I.

Material	Thickness	'R' Value
Inside surface	—	.68
Outside surface	—	.17

FILL IN AT JOB SITE

Potential Savings by Insulation

Well insulated walls should have an 'R' value of 15. If this was so for this building, the wall heat loss would be:

____ × ____ ÷ 15 = ____

Net Wall Area (from box above) | District Heating Factor | 'R' Value | Potential Heating Units

Subtract the potential heating units from those now required and Enter Here..... ____

Potential Heating Savings

TYPE OF HEAT LOSS	HEATING UNITS REQUIRED	POTENTIAL HEATING SAVINGS	PROPOSED CHANGES TO STRUCTURE	HEATING UNITS TO BE SAVED
CONDUCTION THRU: WALLS				

③ Use the instructions on page 11 of the FEA Winterization Manual to assess which potential savings can be obtained most successfully.

④ Fill out the following Summary Table by entering the "Heating Units Required" and the "Potential Heating Savings" from the corresponding tables at the bottom of pages 2 through 7. Then, write in the "Proposed Changes" and "Heating Units to be Saved" by such changes.

HEAT REQUIREMENT ESTIMATES (Annual Heating Units Needed)

TYPE OF HEAT LOSS		HEATING UNITS REQUIRED	POTENTIAL HEATING SAVINGS	PROPOSED CHANGES TO STRUCTURE	HEATING UNITS TO BE SAVED
INFILTRATION	From Page 2				
CONDUCTION THRU: FLOORS	Page 3				
CONDUCTION THRU: CEILINGS	Page 4				
CONDUCTION THRU: SINGLE-GLASS WINDOWS	Page 5				
CONDUCTION THRU: DOORS & DOUBLE-GLASS WINDOWS	Page 6				
CONDUCTION THRU: WALLS	Page 7				
TOTALS					

⑤ Use the space below to calculate the quantities and cost of materials needed to make the proposed changes to the building.

⑥ Fill in job sheet on opposite page.

JOB SHEET A

THIS PAGE IS REMOVABLE FOR USE AT JOB SITE

Name _____

Address _____

Type of Materials	Quantity Required	Estimated Cost	Location Where Materials Are To Be Installed (Walls, Ceiling, etc.)	Installation Diagram No.	Special Instructions
	(INSERT CARBON PAPER UNDER TABLE AT TOP OF PAGE ONLY)				

Map or directions for locating home:

FILL IN AT JOB SITE

WORK RECORD

Activity	Date	Supervisor	Comments
Order Materials			
Install Materials			

JOB SHEET B

THIS PAGE IS RETAINED WITH JOB BOOK AS PERMANENT RECORD

Type of Materials	Quantity Required	Estimated Cost	Location Where Materials Are To Be Installed (Walls, Ceiling, Etc.)	Installation Diagram No.	Special Instructions

Total Cost ☐

7 PAY-OFF TIME

This is the number of seasons for fuel savings to pay off the cost of winterization.

☐ Total Cost (from job sheet above)

☐ Fuel Factor
Fuel Oil = 1
Natural Gas = 120
Electricity = 30

X ☐ Total Heating Units Saved (From page 8)

X ☐ Price of Fuel Per gal, cu.ft., KWH

= ☐ "Pay-off" Time (seasons)

DISTRICT HEATING FACTOR

Northeastern United States

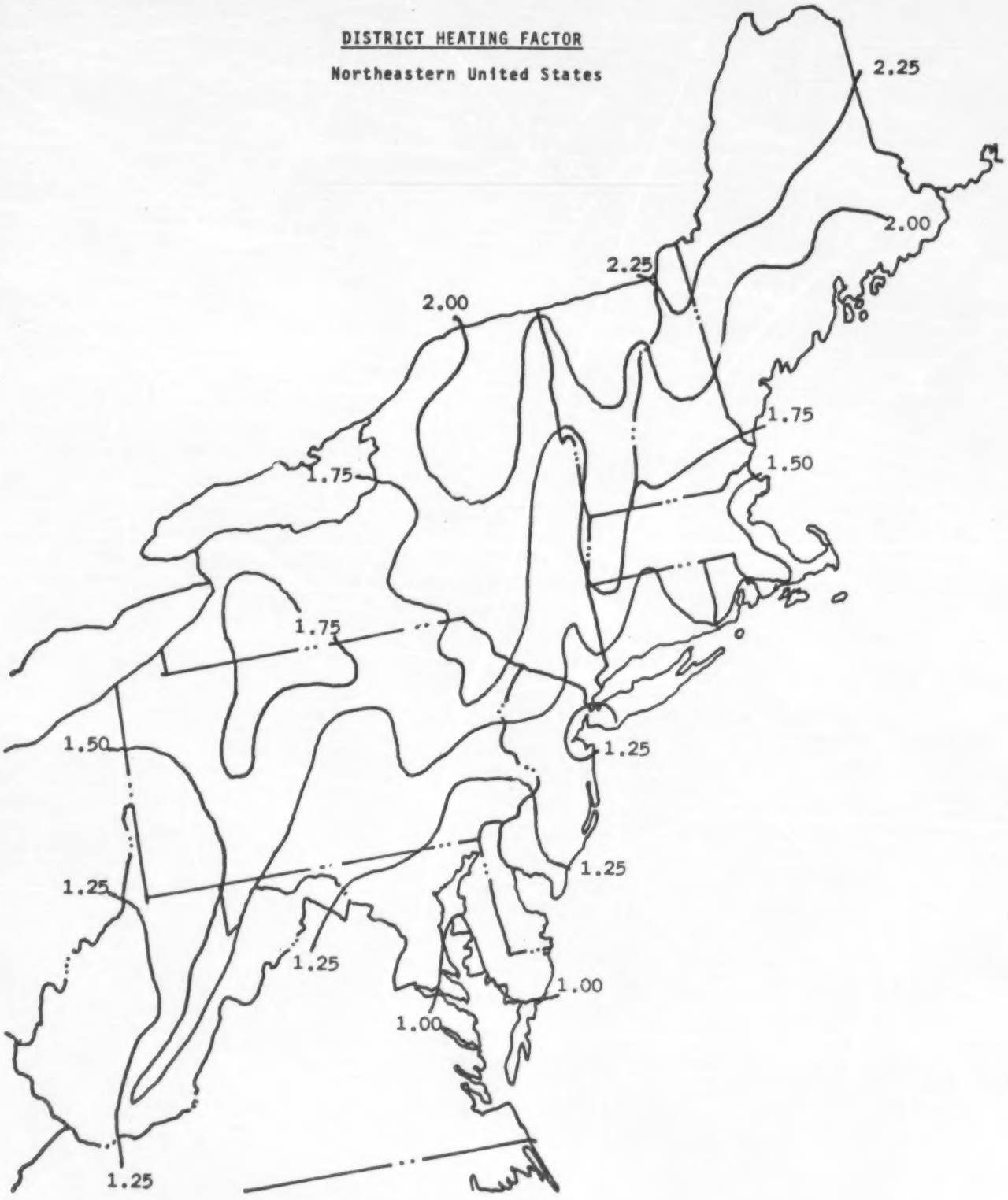


TABLE I. INSULATION VALUE OF COMMON MATERIALS

Source: ASHRAE Guide and Data Book

MATERIAL	THICKNESS	'R' VALUE
Air Film and Spaces		
Air space, bounded by ordinary materials	3/4" or more	0.91
Air Space, bounded by aluminum foil	3/4" or more	2.17
Exterior surface resistance	- -	0.17
Interior surface resistance	- -	0.68
Masonry		
Sand and gravel concrete block	8"	1.11
Sand and gravel concrete block	12"	1.28
Lightweight concrete block	8"	2.00
Lightweight concrete block	12"	2.13
Face brick	4"	0.44
Concrete cast in place	8"	0.64
Building Materials - General		
Wood sheathing or subfloor	3/4"	1.00
Fiber board insulating sheathing	3/4"	2.10
Plywood	5/8"	0.79
Plywood	1/2"	0.63
Plywood	3/8"	0.47
Bevel lapped siding	1/2" x 8"	0.81
Bevel lapped siding	3/4" x 10"	1.05
Vertical tongue and groove board	3/4"	1.00
Drop siding	3/4"	0.94
Asbestos board	1/4"	0.13
3/8" gypsum lath and 3/8" plaster	3/4"	0.42
Gypsum board	3/8"	0.32
Interior plywood panel	1/4"	0.31
Building paper	--	0.06
Vapor barrier	--	0.00
Wood shingles	--	0.87
Asphalt shingles	--	0.44
Linoleum	--	0.08
Carpet with fiber pad	--	2.08
Hardwood floor	--	0.71
Insulation Materials (mineral wool, glass wool, wood wool, etc.)		
Blanket or batts	1"	3.70
Blanket or batts	3 1/2"	11.00
Blanket or batts	6"	19.00
Loose fill	1"	3.33
Rigid insulation board (sheathing)	3/4"	2.10
Windows and Doors		
Single window	--	Approx. 1.00
Double window	--	Approx. 2.00
Exterior door	--	Approx. 2.00

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